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A

GENERAL SYSTEM

OF

CHEMICAL KNOWLEDGE;

AND ITS

APPLICATION

TO THE

PHENOMENA OF NATURE AND ART.

BY A. F. FOURCROY,

Of the National Institute of France, Counsellor of State, Professor
of Chemistry at various Public Establishments, Member
of many Academies, &c.

IN ELEVEN VOLUMES.

TOGETHER WITH A SET OF SYNOPTIC TABLES, IN LARGE FOLIO.

TRANSLATED FROM THE ORIGINAL FRENCH,

BY WILLIAM NICHOLSON.

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A
SYSTEM
OF
CHEMICAL KNOWLEDGE.

CONTINUATION OF
SECTION FIFTH.
ARTICLE XII.
GENUS XI.

Earthy and Alkaline Carbonates.

SECTION I.

Concerning the Generic Characters of theſe Salts.

1. THE carbonates, or ſaturated combinations of the carbonic acid with earthy and alkaline baſes, are the laſt genus of ſalts according to my arrangement; becauſe the general attraction of that acid for the baſes is the weakeſt and moſt eaſily deſtroyed. Although theſe ſalts are, in hiſtorical order, the laſt known, or the moſt recently diſcovered, their

properties have been more deeply inveſtigated, and better determined, in the thirty years during which they have been examined, than thoſe of the greater part of the preceding genera; and there is no department of chemiſtry of which the hiſtory is more complete, exact, and luminous. They hold a rank ſo much the more diſtinguiſhed among ſaline compounds, becauſe, in proportion as their properties have been diſcovered, they have ſuddenly brought into chemiſtry a maſs of new knowledge, and have explained a great number of phenomena, that were either unknown, or ill deſcribed before their diſcovery. It may alſo be ſaid, that by deſtroying many errors, uncertainties, and prejudices, reſpecting the reſult of moſt chemical operations, the ſtudy of the carbonates, and of their mutual actions, has ſo greatly contributed to the progreſs of the ſcience, as in reality to have given it a new aſpect.

2. It is to the illuſtrious Dr. Black that we owe the firſt knowledge of theſe ſaline ſubſtances; confounded, before his time, with the alkalis and alkaline earths, of which we then knew neither the different ſtates nor degrees of purity. This great reſult of enlightened genius bears date 1756. By conſidering the carbonic acid, which with Hales he named fixed air, as rendering the alkalis mild, cauſing them to cryſtallize, and giving them the property of efferveſcing with acids, by proving the attraction of that acid to be more ſtrong for lime

than for alkalis, and the production of cauſticity as the neceſſary conſequence of its abſorption by pure calcareous earth, Profeſſor Black has opened a new and immenſe career, in which contemporary chemiſts ſoon made great progreſs, and which has preſented to them a ſeries of highly important diſcoveries.

Lavoiſier himſelf was one of the firſt engaged in this purſuit with M. Cavendiſh, between the years 1766 and 1772; and theſe philoſophers, by determining the quantities of this fugacious and volatile being, which they did not yet venture to call an acid, both in its diſengaged and in its fixed ſtate, firſt gave an example of precifion, which has been followed in ſubſequent reſearches.

Chaulnes ſoon diſcovered, in 1773, the art of cryſtallizing the alkalis, by keeping their ſolutions immerſed and agitated over a veſſel of beer in fermentation, and ſaturating them with the gaſeous acid diſengaged from the beer.

Bergmann at the ſame time examined it, and in a learned diſſertation concerning this new body, which he called aërial acid, he deſcribed the properties of moſt of its combinations with alkalis.

Since the time of that able chemiſt nothing more has been done than to add, by degrees, ideas more definite and more enlarged reſpecting each of theſe ſalts: and the ſucceſſive labours of Rouelle, of Citizen Berthollet, of Mr. Kirwan, of Citizen Guyton, of Pelletier, of Bayen, of Meſſrs. Withering, Pearſon, Tennant, and of the greater number of modern chemiſts, have ſo far advanced the knowledge of earthy and alkaline carbonates, that ſcarcely any thing more remains to be done reſpecting their hiſtory; and when we conſider all the ſpecies individually, there are much fewer deficiences than in the other genera.

3. The carbonates were firſt termed mild and effervefcent earths or alkalis, conſidering only their differences in that ſtate compared with their cauſtic or pure ſtate. Bergmann denominated them aerated earths or alkalis, in conformity to his denomination of aërial acid. Citizen Guyton, adopting the term of mephitic acid, calls them mephites of ſuch or ſuch a baſe. The name of cretaceous acid which I had adopted in 1778, with Bucquet, induced us to name them earthy or alkaline chalks. But when the nature of the acid which forms them was well known, and when it was deſcribed under the name of carbonic acid, the word carbonates was formed, to expreſs theſe ſaline combinations.

4. The greater part of the earthy and alkaline carbonates exiſt in nature; where they form very conſiderable maſſes to which the globe owes part of its ſtrata and of its ſolidity. Some are found in leſs abundance, and occupy only certain points, or conſtitute only narrow veins. It is rare that theſe ſalts are found much inſulated and very pure, though many

are

are met with even in that ſtate; moſt frequently two or three are blended together, or depoſited with ſilex, alumine, and metallic oxides; they rarely form any part of the primitive mountains, but are much more frequently found in the ſecondary mountains, or thoſe of latter formation.

5. Thoſe which nature affords pure may be uſed in the experiments of chemiſtry in their natural ſtate; the ſame ſubſtances are often prepared by art, by directly uniting the carbonic acid with earthy or alkaline baſes, by receiving this gaſeous acid in their ſolutions till they are well ſaturated, and till they refuſe to abſorb any more, or are intirely depoſited or precipitated, when the character of theſe carbonates is to be inſoluble. We are ſure to have theſe ſalts very pure, when the baſes which are employed to form them are themſelves very pure, and when care is taken to combine only ſuch carbonic acid as is deprived of that ſmall portion of the acid which is uſed to diſengage it, and is apt to riſe with it. For this reaſon, before it is received in the ſolutions of earths or alkalis intended to be ſaturated, it will be proper to paſs through it a ſmall quantity of water in which it may depoſit that portion of foreign acid.

6. Although the phyſical properties are little adapted to characterize the genera of ſalts, and belong much rather to the ſpecies, there are

ſome of them which are to be found in the carbonates, and ought to be conſidered generally through the whole of the ſpecies. Theſe ſalts are moſtly without taſte, or have an earthy one, and ſometimes an alkaline or urinous taſte; but even then it is weak and ſupportable. Hence they were formerly called mild alkalis. All of them are capable of aſſuming regular forms, and there are no ſalts in which Nature ſeems more to delight, or which it is apparently more eaſy to produce in polyhedral cryſtals, of well-determined figures, but they are always extremely varied. The hardneſs of ſome is very great, whilſt others are friable, or even without aggregation. It was the ſolidity of the firſt added to their inſipidity and apparent inſolubility, which cauſed them to be claſſed ſo long amongſt the earths by mineralogiſts.

7. Light does not change them; moſt of them are tranſparent; ſome produce double refraction. Heat decompoſes almoſt all of them by ſubliming their water and carbonic acid in ſuch a manner as to reduce them to the ſtate of pure or inſulated baſes: in fact, this decompoſition, though very eaſy in the greater number, is extremely difficult in ſome; which depends on the various degrees of attraction of the ſeveral baſes for carbonic acid.

8. Oxigen and azote, neither in the gaſeous nor combined ſtate, have any action on the carbonates. Neither does air by its humidity

produce any change in them; they are not deliqueſcent; ſome of them are even very efflореſcent.

9. They vary much as to the manner in which combuſtible bodies affect them. Carbon frequently renders their acid more volatile, and more eaſily ſeparated by the action of heat, without our being able to know how it produces this ſingular effect. Phoſphorus, ſtrongly heated with the carbonates, decompoſes their acid, becoming at the ſame time phoſphoric acid which forms phoſphates with the baſes, and inſulates the carbon, ſo as to render the mixture black. This decompoſition which does not take place with equal facility in all the carbonates, and in ſome of them not at all, appears the more ſingular at firſt conſideration, becauſe carbon, ſingly and alone, decompoſes the phoſphoric acid, and has really more attraction for oxigen than the phoſphoric acid has. To explain this phenomenon it is neceſſary to ſtate, that as carbon decompoſes the phoſphoric acid by itſelf, ſo, on the other hand, phoſphorus does not decompoſe the inſulated carbonic acid; but again, that carbon can not act on the phoſphoric acid united to its baſes, and does not produce phoſphorus with theſe ſalts, as has been ſeen in the characters of the genera of phoſphates; and alſo that phoſphorus decompoſes the carbonic acid only when it is united to certain baſes, or in the ſtate of carbonates. It is, therefore, to the

attraction of theſe baſes for the phoſphoric acid that we muſt aſcribe the decompoſition of the carbonic acid of carbonates by phoſphorus, and the non-decompoſition of phoſphates by carbon. In this remarkable action may be ſeen an effect and inſtance equally ſtriking of what I have called diſpoſing attraction.

10. The carbonates divide themſelves into two claſſes with regard to the action of water; ſome are nearly inſoluble, others are eaſily diſſolved; ſome are diſſolved more readily in warm than in cold water. Specific characters are derived from this property.

11. All the other acids have more attraction for the earthy and alkaline baſes than the carbonic acid; all of them, if poured upon the ſolid and cryſtallized carbonates, cauſe a lively efferveſcence by the diſengagement of carbonic acid, in the form of an elaſtic fluid. This efferveſcence, which was formerly conſidered as a character of the alkalis, is only a character of the carbonates. The change of the carbonic acid, which they contained in a ſolid ſtate, to the ſtate of gas, or of an elaſtic fluid, announces that it is then impregnated with caloric diſengaged from the new combination of the baſes with the decompoſing acids, and that this caloric is united to the carbonic acid, to which it gives the gaſeous form.

Accordingly there is no heat produced during theſe decompoſitions, which are accompanied by efferveſcence, or a ſpecies of ebullition; whereas there is a very ſtrong heat when theſe earthy, pure, and cauſtic alkaline baſes are united to acids which ſaturate them without motion or the diſengagement of bubbles.

12. This decompoſition of the carbonates by the nitric, muriatic, or ſulphuric acids, is uſed for collecting the carbonic acid in the gaſeous form. It is performed in glaſs bottles, with recurved tubes, which conduct the gas under bell-glaſſes full of water, or into flaſks full of different liquids that are to be impregnated with the acid.

13. The carbonic acid unites in exceſs with moſt of the carbonates, or rather, it renders them ſoluble in water, though they may not be ſoluble alone. It appears, that it is thus that nature effects the diſſolution of earthy carbonates in water, and cauſes them to cryſtallize, as will be ſeen in the hiſtory of their ſpecies.

14. The carbonates decompoſe many ſalts which the mere baſes could not decompoſe, by means of the double attraction exerted from the union of the carbonic acid with their baſes.

Since the diſcovery of theſe decompoſitions, many other diſcoveries have been made reſpecting ſaline ſubſtances, their nature and products; and the doctrine of elective attractions has been greatly illuſtrated.

15. The uſes of earthy and alkaline carbonates are extremely numerous; they frequently afford the chemiſt the moſt valuable means of accurate analyſis and ſyntheſis. A number of

applications of theſe bodies to the arts have been ſucceſsfully made. Moſt of them conſtitute the moſt uſeful medicines we poſſeſs, which can be prepared, with the moſt definite knowledge of their nature and of their virtues.

In a word, the mineralogiſt, by examining them in collections, and the geologiſt in his travels, arrive, by the light which they afford to chemiſtry, to great and important ſpeculations concerning their influence and their formation, as well as the theory of mountains, and the operations of the waters which are perpetually diſplacing and changing their beds.

16. In the application of my ſyſtematic arrangement of ſalts, founded on the relative attraction of the baſes for the acid which conſtitutes the genus, I diſtinguiſh thirteen diſtinct ſpecies of carbonates, and I arrange them in the following order:

1. Carbonate of barites.
2. Carbonate of ſtrontian.
3. Carbonate of lime.
4. Carbonate of pot-aſh.
5. Carbonate of ſoda.
6. Carbonate of magneſia.
7. Carbonate of ammonia.
8. Ammoniaco-magneſian carbonate.
9. Carbonate of glucine.
10. Carbonate of alumine.
11. Carbonate of zircone.
12. Ammoniaco-zirconian carbonate.
13. Ammoniaco-glucinian carbonate.

SECTION II.

Concerning the Specific Characters of Earthy and Alkaline Carbonates.

SPECIES I.

Carbonate of Barites.

A. *Synonymy; Hiſtory.*

1. IT is but twenty-ſix years, ſince 1776, that we have poſſeſſed a knowledge of this ſalt, and, but twenty-two ſince it was found native. It is to Scheele and to Bergmann that we are indebted for its diſcovery, and to Dr. Withering, an Engliſhman, we owe the firſt information of its exiſtence in nature. Its properties have been ſucceſſively examined by Kirwan, Pelletier, Hope, and myſelf; little now remains to render our knowledge of this ſubſtance complete.

2. It has been called aerated ponderous ſpar, aerated baroſelinite, aerated ponderous earth, mephite of barites, chalk of barites, and Witherite, becauſe Dr. Withering diſcovered it.

B. *Phyſical Properties; Natural Hiſtory.*

3. THE carbonate of barites, artificially prepared, has the form of a white inſipid powder, of the ſpecific gravity of 3,763.

4. That which has been found moſt abundantly at Alſton-Moor, in Cumberland, is in ſtriated, lamellated, and ſemi-tranſparent maſſes: its preſumptive primary form is that of the hexahedral priſm. It ſpecific gravity is 4,331.

5. It is alſo found in Schotland, in Sweden, and in the coal-mines of Lancaſhire. It is frequently mixed with ſulphate of barites, carbonate of lime, the oxides of iron, and the ſulphate of the ſame metal. Though the ſulphate of barites is much more frequently found than the carbonate, it may be preſumed that this laſt will be moſt frequently found accompanying the former: this inquiry ought to excite the greateſt zeal amongſt mineralogiſts, ſince, as we may judge from its properties, this earthy ſalt will hereafter become of the greateſt uſe in the arts.

C. *Extraction; Preparation; Purification.*

6. When we poſſeſs the native carbonate of barites, nothing is required but to chooſe it very pure, very lamellated, free from metallic oxides and other extraneous bodies.

7. There are four principal methods of preparing it artificially, by expoſing a ſolution of pure barites to the air, where it acquires a pellicle of this ſalt by abſorbing the carbonic acid of the atmoſphere; by paſſing through this ſolution, ſome carbonic acid gas which becomes fixed, and immediately forms an abundant precipitate;

cipitate; by decompoſing the native ſulphate of barites in the dry method, by means of fire with the carbonate of pot-aſh or ſoda, and then waſhing the mixture with water, which carries off the ſulphate of alkali in the ſtate of ſolution, and leaves the carbonate of barites inſoluble; and laſtly, by precipitating the diſſolved nitrate or muriate of barites, by ſolutions of the carbonate of pot-aſh, of ſoda, or of ammonia. The two firſt and the fourth proceſſes afford this ſalt very pure when the precipitates are well waſhed. The third affords only a mixture of carbonate and ſulphate of barites, this laſt not being completely decompoſed.

D. *Action of Caloric.*

8. Neither the artificial, nor the natural carbonate of barites, loſe any of their carbonic acid by the action of fire. The firſt contains much more water than the ſecond, and this liquid, not being ſtrongly adherent to that pulverulent ſalt, it loſes 0,28 of its weight, and part of its acid eſcapes with it by the calcination; whilſt the ſecond loſes nothing. Dr. Withering firſt obſerved, that this ſalt is fuſed by a ſtrong heat, rather than permits the carbonic acid which it contains, to eſcape. It only becomes of an opaque white, like porcelain biſcuit; and alſo aſſumes a bluiſh green colour internally.

E. *Action of the Air.*

9. It is totally or completely unchangeable by the air.

F. *Action of Water.*

10. Cold water ſcarcely at all affects the carbonate of barites. I have neverthele ſs found that when left, during a long time in contact with that of Alſton-Moor in very fine powder, it diſſolved $\frac{1}{4304}$; and that water boiled for a long time with this native ſalt carried off from it $\frac{1}{2304}$.

G. *Decompoſition; Proportion.*

11. Dr. Hope has found, that by treating the carbonate of barites in a crucible of black lead, it loſt its carbonic acid, whilſt in an earthen crucible it permitted nothing to eſcape. Pelletier, who has examined and confirmed this ſingular experiment, the theory of which is not known to us, has repeated it in the moſt accurate manner. He made a paſte of one hundred parts of this ſalt, and ten parts of charcoal, which he heated in the middle of charcoal powder, and by that ſimple proceſs he obtained barites pure and ſoluble; this then is a means of extracting that cauſtic alkali very

pure, very cryſtallizable; in a word, poſſeſſing all the properties aſcribed to that ſubſtance.

12. Though all the acids decompoſe the carbonate of barites, each of them produce that effect with certain particular phenomena. The ſulphuric acid, concentrated or diluted with two or three parts of water, does not diſengage the carbonic acid without effervefcence, unleſs aſſiſted by an elevated temperature. The concentrated nitric acid does not act on it; it diſſolves it completely in the cold, and with a lively effervefcence when it is diluted with water, and forms nitrate of barites which remains diſſolved in the fluid; ſo that there is no ſolid reſidue, when the carbonate of barites is very pure, as I have ſeen that of Alſton-Moor.

13. This ſalt, in ſmall pieces, as in the two caſes before-mentioned, is not affected by the concentrated muriatic acid; when that acid is diluted, it attacks the carbonate of barites with a kind of decrepitation, and diſengages from it carbonic acid gas in large intermitting globules when the acid is very ſtrong, and a continual diſcharge of ſmall globules, till it is completely diſſolved when the acid is ſo very weak as to weigh no more than between $\frac{1}{25}$ or $\frac{1}{30}$ more than water. The concentrated muriatic acid, which in the cold does not act at all on the carbonate of barites, diſſolves it with a ſtrong effervefcence when aſſiſted by heat; but, in that caſe, the ſalt forms itſelf in a maſs. When concentrated

and fuming muriatic acid is poured into a mixture of carbonate of barites, and of that weak acid which eaſily decompoſes it, it ſuddenly ſtops the effervefcence and the diſſolution; but by adding ſome water, the action again commences. Solid muriate of barites, thrown into the mixture while effervefcing, alſo ſtops it. We may perceive in theſe facts the influence of water, and of its caloric which ſeparates the particles of the acid and thoſe of the carbonate of barites, and favours its ſolution by its own decompoſition. I explained the ſubject of the complicated attractions which take place in theſe mixtures, in the Memoir which I publiſhed in 1790, concerning the analyſis of the native carbonate of barites of Alſton-Moor. (See Annales de Chimie, tom. iv. pag. 62, and Dictionnaire de Chimie de l'Encycloped. Method. tom. iii. p. 9.)

14. The phoſphoric and fluoric acids alſo act on the carbonate of barites, and drive off the carbonic acid by uniting to its baſe, but leſs eaſily than the nitric and weak muriatic acids.

15. Liquid carbonic acid, or acidulated water, diſſolves $\frac{1}{830}$ of this ſalt in powder, more than double, as it appears, of that which boiling water diſſolves. This ſolution is decompoſed in the air, and by the addition of any of the ſoluble alkaline and earthy ſubſtances, which are quickly diſſolved and ſeize the carbonic acid, at the ſame time precipitating the barites. It is probable that it is by this acid that nature

diſſolves and cryſtallizes this ſalt in the bowels of the earth.

16. The carbonate of barites does not act on the ſalts; but when it is ſtrongly heated even with thoſe compounds of which the principles are moſt adherent, previouſly mixing ſome charcoal with it, which poſſeſſes, as has been already obſerved, the property of diſengaging its carbonic acid, the barites is ſet at liberty, and attracts the acids and diſengages their baſe. By this proceſs we may decompoſe the ſulphates and muriates of pot-aſh, ſoda, &c.

17. Chemiſts who have analyzed the carbonate of barites, whether artificial or natural, and who have endeavoured to determine the proportion of its principles, do not perfectly agree in the reſult of their analyſis. Mr. Kirwan ſays, that a hundred parts of this artificial ſalt contain,

Barites	65
Carbonic acid	27
Water	28

According to him, one hundred parts of the native carbonate of barites are compoſed of

Barites	78
Carbonic acid	20
Sulphate of barites	2

In my examination of this ſalt from Alſton-Moor, choſen in a very pure ſtate, I could not find the ſulphate of barites. It preſented to me the following proportions,

Barites	90
Carbonic acid	10

I may, neverthelefs, obferve, that the proportion of barites appeared to be a little too great, and that in its weight it is neceſſary to include that of the water which I do not know, but which I admit, though M. Kirwan denies its exiſtence in this ſalt. Pelletier found in 100 parts of this native ſalt,

Barites	62
Carbonic acid	22
Water	16

H. *Uſes.*

18. THE carbonate of barites is only uſed in the laboratories of chemiſtry, for experiments of demonſtration. When it ſhall be found more abundantly in nature, it will become of the greateſt uſe. It will not only be uſeful in chemiſtry to prepare all the baritic ſalts, but it will render important ſervices to the arts in the formation of many ſaline ſubſtances, and in extracting their baſes. Some phyſicians have propoſed the uſe of this ſalt as a medicine: they ought to be aware that it poiſons animals, and that its medical adminiſtration conſequently demands the moſt ſevere and active circumſpection.

SPECIES II.

Carbonate of Strontian.

A. *Synonymy; Hiſtory.*

1. CRAWFORD firſt ſuſpected that the foſſil found at Strontian in Scotland, and regarded as a carbonate of barites, contained a particular earth. Dr. Hope proved this in November 1793, and named it ſtrontite. M. Klaproth has confirmed this reſult, and diſcovered the carbonate of ſtrontian to be a peculiar ſalt, without knowing the earlier labours of Mr. Hope. Schemeiſſer, of Hamburg, announced it in his work on mineralogy. Blumenbach and Sulzer have called it ſtrontianite. It has been confounded for ſome years with the native carbonate of barites, or Witherite. Pelletier, Citizen Vauquelin, and I, have examined it at Paris, and we are convinced that, notwithſtanding certain analogies with the native carbonate of barites, this ſalt differs from it in many properties already deſcribed by Meſſrs. Crawford, Hope, and Klaproth, and which I ſhall proceed to enumerate.

B. *Phyſical Properties; Natural Hiſtory.*

2. THE carbonate of ſtrontian is in needles, or fine ſtriated priſms, which appear to be hex-

ahedral, of a greeniſh-white colour. It weighs from 36,583 to 36,750. According to Pelletier, is has no taſte.

3. It was firſt found at Strontian in Argylſhire, or the county of Argyl, ſituated towards the weſtern part of the north of Scotland. It there accompanies a vein of lead; Citizen Guyot has found it at Lead hills in Scotland, and took it for a carbonate of barites. Citizen Guyton affirms, that it accompanies certain ſpecies of the ſulphate of barites. It is very probable, likewiſe, that it will be found abundantly in France, ſince the ſulphate of ſtrontian has been found there, and it may probably exiſt where this laſt is.

C. *Preparation; Purification.*

4. It may be made artificially, by ſaturating a ſolution of ſtrontian with carbonic acid, or by precipitating the ſoluble ſalt of that baſe by the alkaline carbonates.

5. We have known this ſalt for too ſhort a time to be ſkilled in the method of purifying it from the different ſubſtances which may accompany it in nature; but, to have it very pure we may prefer the artificial mode of preparing it.

D. *Concerning the Action of Caloric.*

6. When the carbonate of ſtrontian is calcined in a crucible without being heated ſo much as to cauſe it to melt, it permits five or ſix parts in the hundred of carbonic acid, to fly off, and afterwards the pure ſtrontian may be ſeparated by hot water, and cryſtallized by cooling. This ſalt is, therefore, more eaſily decompoſed than the carbonate of barites. When it is placed on a ſtrong fire, it attacks the crucible and fuſes it into a glaſs, reſembling in colour the chryſolite, or the pyramidal phoſphate of lime.

E. *Action of Air.*

7. It is entirely unalterable by the air.

F. *Action of Water.*

8. Water has no more action on it than on the carbonate of barites.

G. *Decompoſition; Proportion.*

9. The charcoal with which it is heated, after reducing the mixture into the form of a paſte according to Pelletier's proceſs, favours the diſengagement of the carbonic acid in the ſtate of gas; in this manner it loſes 0,28 of its

weight, and the ſtrontian is found pure, and may be diſſolved in boiling water, from which, on cooling, it falls down in cryſtals. If the carbonate be powdered, and thrown on charcoal well kindled, or on the flame of a burning candle, it exhibits a red ſcintillation. The ſame phenomenon is obſerved with the blow-pipe, which fuſes this ſalt into an opaque vitreous globule, that falls to powder in the open air.

10. The acids decompoſe it, and diſengage from it the carbonic acid with efferveſcence. An hundred parts of this ſalt, being diſſolved in diluted nitric acid, loſt eighty by the efferveſcence that enſued. The muriatic acid acts on it, as on the carbonate of barites; and the muriate of ſtrontian thus produced is diſtinguiſhed, as is well known, from that of barites, chiefly by its property of giving a purple-red colour to flame, its figure, &c. When it is treated with ſulphuric acid, though diſtilled water diſſolves very little of the ſulphate of ſtrontian formed, yet it is rendered very perceptible by the precipitate that muriate of barites occaſions.

11. None of the baſes act on carbonate of ſtrontian, barites excepted; which, if heated with this carbonate, decompoſes it, and leaves its earth uncombined. It has not been obſerved, that the ſalts have any greater degree of action with reſpect to this compound.

12. If theſe properties, the differences of which in theſe firſt two carbonates appear but

feebly marked, and prevented chemiſts for ſeveral years from diſtinguiſhing them from each other, ſhould leave any doubt with regard to their being really diſtinct ſubſtances, let the reader but conſider the inferior ſpecific gravity of the carbonate of ſtrontian, the loſs of part of its acid by fire, the red colour it imparts to flame, and its decompoſition by cauſtic barites, and his doubt will be quickly removed. But he will preſently ſee further proofs of the difference of the two carbonates, in the proportions of their principles, and in their action on the animal economy.

13. According to Pelletier's analyſis, an hundred parts of carbonate of ſtrontian are compoſed of

Strontian	62
Carbonic acid	30
Water -	8

H. *Uſes.*

14. HITHERTO no uſe has been made of the carbonate of ſtrontian: it muſt be obſerved, however, that Pelletier, in his uſeful experiments on this ſalt, found it not to be injurious and poiſonous to animals, as the carbonate of barites is; which ſhould induce phyſicians to inquire into the properties of the ſoluble ſalts that have ſtrontian for their baſe, and compare them with the properties of the ſaline compounds formed with barites.

SPEÇIES III.

Carbonate of Lime.

A. *Synonymy; Hiſtory.*

1. THERE are few ſaline ſubſtances, of which the hiſtory is ſo intereſting as that of the carbonate of lime. Exiſting in nature in vaſt quantity; contributing to the formation of mountains, of which it frequently conſtitutes the greater part; inceſſantly depoſiting itſelf at the bottom of the ſea, where for a time it ſerves as the ſupport, or covering, or ſkeleton of innumerable myriads of animals; exhibiting itſelf in a thouſand ſubterranean cavities, or clefts, in the brilliant and varied form of tranſparent and regular cryſtals; here accumulating in the earth in immenſe ſtrata of ſtone, there pendant in ſtalactites from the ſummits of caverns, and further on congealed, or incruſted upon different bodies; in one place compoſing the ſoil of extenſive plains, and receiving the ſeeds of future harveſts; in others, not a little numerous, diſſolved in the waters, and flowing as a liquid with them; raiſed by the labours of man to the ſurface of the earth, and ſerving to form the edifices he erects on it, or burned in kilns to that lime, which is neceſſary to cement them; in a word, introduced into numerous manufactories for various uſes; the carbonate of lime is

at once intereſting to the geologiſt, the mineralogiſt, the chemiſt, the philoſopher, the naturaliſt, the manufacturer, the artiſt, and the mechanic. Accordingly it has been the object of repeated labours and reſearch, ſince the brilliant period when Black began to render it accurately known, and, in ſome degree, to remove it from the claſs of ſtones, or earths into that of ſalts. The ſucceſſive experiments of Bergmann, Prieſtley, Rouelle, Lavoiſier, and ſeveral others, have developed all its chemical properties; while the mineralogical ſtudies of Hill, Romé de Liſle, Kirwan, and Citizen Haüy have ſcrutinized its different native varieties, its forms ſo numerous and diverſified, and the laws that have preſided over the ſtructure of theſe ſeveral forms.

2. As the carbonate of lime has been an object of very extenſive reſearch at once to the mineralogiſt, and to the chemiſt, it would be found denominated by a multitude of ſynonymes, if we reckon among its names thoſe given to the various foſſils it exhibits. Thus it is *the calcareous matter* in general, *calcareous earth*, *chalk*, *lime-ſtone*, *free-ſtone*, *tufa*, *cron*, *falun*, *pure marble*, *calcareous ſpar*, *incruſtations*, *guhrs*, *ſtalactites*, *alabaſters*, *Spaniſh white*, according to the forms it affects, the appearances it exhibits, the places it occupies, the reſemblances it diſplays, or the uſes for which it is deſigned. The chemiſts, on their part, in proportion as they have become better

acquainted with it, have ſucceſſively deſignated it by the appellations of *mild lime, effervеſcent lime, aerated lime, mephite of lime, calcareous chalk*, and, finally, of carbonate of lime, or calcareous carbonate, the laſt name given in the methodical nomenclature, and generally adopted in all the languages, and all the works of modern chemiſtry.

B. *Phyſical Properties; Natural Hiſtory.*

3. The carbonate of lime is deſtitute of flavour, which occaſioned it long to be conſidered in its ſolid ſtate as a ſtone. It cryſtallizes in tranſparent rhombs, and undergoes very numerous varieties of figure. It then exhibits a double refraction. It weighs 2,700.

4. As it is very abundant and various in nature, lithologiſts have formed of it one entire claſs of earths or ſtones, under the name of calcareous. They have divided them into an order, genera, ſpecies, and varieties, of which they have deſcribed very numerous ſeries; and they might be ſtill farther enlarged, without hope of ever enumerating, or bringing together all that occur in nature. This natural hiſtory of calcareous matter, one of the foundations of our globe, and one of the moſt abundant of the materials that compoſe it, may be reduced, however, to a few general and ſimple outlines.

5. We may form of it ſix principal genera, having reſpect to the principal differences, which

this ſalt affects in its natural ſtate. The firſt comprifes the primitive carbonate of lime; that which is found in the primitive mountains or thoſe primarily formed, though we are unable there to detect its ancient origin. It is in horizontal or vertical ſtrata, filling the clefts of granite or of ſchiſtus; it is often ſufficiently pure, ſometimes mixed with ſilex or alumine.

To the ſecond genus belong the teſtaceous, madreporous, and lythophytic depoſitions, which are ſo abundant in the more recent mountains, form the ſoil of ſo many plains, and extend from thoſe foſſil ſhells, the ſpecies of which are eaſily diſtinguiſhed, to the earths reſulting from their pulverization, which exhibit only a few fragments ſtill capable of being aſcertained to have belonged to marine animals, of which they are the accumulated ſpoils, and, in ſome meaſure, the ſepulchral monuments. In this genus are to be claſſed all the madrepore and foſſil ſhells which naturaliſts deſignate by the addition of the word *lithe* to their original name; the faluns, crons, ſhelly earths, lumachelloes, &c.

The third genus will include the calcareous earths and ſtones properly ſo called; that is to ſay, pulverized carbonate of lime, almoſt entirely deſtitute of perceptible organic forms, and conſtituting the chalks, ſtone-marrow, tufa, and coarſe and fine-grained calcareous ſtones.

In the fourth genus will be arranged the marbles, of greater hardneſs and finer texture than the calcareous ſtones, and the varieties of which are immenſe with regard to the different matters mingled with them, and the differences of the tints, ſpots, and colours, which theſe matters occaſion.

To the fifth genus will be referred the calcareous concretions, compriſing the incruſtations, oſteocollæ, pretended petrifactions, ſtalactites, and alabaſters.

In fine, to the ſixth and laſt genus will appertain the *calcareous ſpar* of naturaliſts, or the pure native cryſtallized carbonate of lime.

6. The laſt-mentioned lithologic genus is the true ſalt, the properties of which ſhould be examined with the greateſt care. It is that in which chemiſts may conſider the carbonate of lime as very pure, and which they ought to ſelect for their experiments. No earthy ſalt appears ſo abundant throughout the globe; none exhibits ſo many varieties: beſide thoſe of colour, purity, tranſparency, ſemi-tranſparency, or opacity, various mixtures, the mode in which it exiſts in the earth, or its ſituation; Hill has deſcribed a number of modified forms of it; and, in fact, the algebraic inveſtigations of the able cryſtallographer Haüy have given him as their reſult a number of more than eight millions of figures. Every day new cryſtals of it are diſcovered; already we know forty-two varieties of it with regard to form; and though

it is probable, that the circumſtances neceſſary to produce the immenſe varieties, which the calculation of decrements ſhows to be poſſible, will not occur in nature, there can be no doubt that many yet remain to be diſcovered.

7. Impoſſible, and even uſeleſs, as it would be in a ſyſtematic work on chemiſtry, to give a detailed account of the varieties already found in the forms of the native cryſtallized carbonate of lime, I ſhall confine myſelf here to a deſcription of its primitive form, and of twelve of its principal varieties; ſelecting, after Citizen Haüy himſelf, the moſt remarkable, or thoſe which it is of the moſt importance to diſtinguiſh.

Primitive form: an obtuſe rhomboid, the plane angles of which are about 101½ degrees, 78½ degrees; integral mole-cule the ſame.

VARIETIES.

A. *Primitive calcareous Carbonate.* This cryſtal has a double refraction: it depends on the circumſtance, that the images of objects appear double when they are ſeen through two parallel faces of this rhomboidal ſalt, and through two faces inclined to each other in other tranſparent minerals having this property.

It has been diſcovered, that all double refracting cryſtals have one direction in which objects appear ſingle. In general this effect takes place when one of the faces, through which the object is viewed, is perpendicular or parallel to the axis, according to the difference of the ſpecies.

B. *Equiaxal calcareous Carbonate*, vulgarly lenticular: a very obtuſe rhomboid, the axis of which is equal to that of the nucleus.

C. *Inverſe calcareous Carbonate;* the muriatic of De Liſle: an acute rhomboid, in which the plane angles are equal to the reſpective inclinations of the faces of the nucleus, and reciprocally. From this inverſion the name of the variety is taken.

D. *Contraſting calcareous Carbonate:* a very acute rhomboid, in which the plane angles are equal to the reſpective inclinations of the faces of the very obtuſe or equiaxal rhomboid, and reciprocally; which forms a ſort of contraſt.

E. *Metaſtatic calcareous Carbonate*, vulgarly *hog's tooth:* a dodecahedron with ſcalene triangles, in which the great angle of each triangle is equal to the obtuſe angle of the nucleus; and the leaſt inclination of the faces equal to the greateſt of the faces of the nucleus, whence reſults a ſort of *metaſtaſis*, or tranſlation of the angles of the nucleus on the ſecondary cryſtal.

F. *Cuboid calcareous Carbonate*: a rhomboid ſlightly acute, differing little from a cube; diſcovered by Citizen Dodun, near Caſtelnaudari.

G. *Priſmatic calcareous Carbonate :* a regular hexahedral priſm.

H. *Amphipentagonal calcareous Carbonate :* when its priſm is very ſhort is called *nail-headed*: a priſm with ſix pentagonal ſides, terminated at each end by three pentagons different from the former.

I. *Alternate calcareous Carbonate :* a priſm with ſix elongated hexagonal ſides, terminated at each end by ſix quadrilateral faces uniting in a pyramid. The acute angles of the lateral hexagons point alternately upward and downward. Sometimes the ſides are reduced to the quadrilateral figure.

K. *Emergent calcareous Carbonate :* the metaſtatic, with each of its ſummits intercepted by three rhombs parallel to the primitive faces, ſo that the nucleus ſeems to emerge from the ſecondary cryſtal.

L. *Analogical calcareous Carbonate :* the alternate, with each of its ſummits intercepted by three trapezoids belonging to the equiaxal. The name analogical is taken from the different analogies which this variety exhibits, compared with others of the ſame ſpecies, or of a different ſpecies.

M. *Aſſorted calcareous Carbonate :* the alternate, with each of its ſummits intercepted by three rhombs parallel to thoſe of the nucleus. The name *Aſſorted* is taken from this circumſtance, that the laws of decrement are perceptible from the ſimple poſition of the facets reſulting from them with reſpect to the extreme rhombs which belong to the nucleus.

C. *Preparation.*

8. It is obvious that a ſalt which Nature offers ſo frequently and ſo abundantly in almoſt all places or points of the globe, and which can ſo eaſily be procured in a ſtate of purity, requires neither preparation nor purification. It may be prepared artificially, however, by combining the carbonic acid with lime. In the hiſtory of the latter it has been ſeen that this acid, in a gaſeous ſtate, is rapidly abſorbed by the ſolution of lime, and that it forms therein a precipitate of calcareous carbonate: to theſe particulars it is to be added, that, to compoſe calcareous carbonate, which ſhall be at the ſame time very pure, it is neceſſary to employ a juſt and well-proportioned doſe of the carbonic acid: if too little be uſed, the firſt precipitate of calcareous carbonate formed, re-diſſolves in the lime-water, and ſeems to form a carbonate with exceſs of lime: if too much be employed, the calcareous carbonate at firſt precipitated re-diſſolves, and diſappears in the exceſs of carbonic acid: it is true, in this caſe, it may be made to re-appear by adding freſh lime-water, or by diſengaging the exceſs of acid by means of fire.

D. *Action of Caloric.*

9. The carbonate of lime, expoſed to a ſudden heat, decrepitates, loſes its water of cryſtallization, becomes white, opaque, and much leſs friable than ſulphate of lime treated in the ſame manner. If it be heated more, the carbonic acid is expelled, flying off in the ſtate of gas. By making this experiment in a cloſe veſſel, and particularly in a caſt-iron retort, or a gun-barrel, to which is fitted a tube paſſing under jars filled with water, we may collect the carbonic acid gas, making nearly 0,32 of the weight of the ſalt. At the ſame time a little hidrogen gas is frequently obtained, in conſequence of the reciprocal action between the water and the ſides of the iron veſſel. If the operation be performed in porcelain tubes or retorts, no hidrogen gas will be produced. Retorts of ſtone or earthen ware let part of the carbonic acid gas eſcape through them, and deceive us reſpecting the reſults, as Rochefoucauld and Prieſtley found upon trial. What remains in the apparatus employed is pure quick-lime.

10. In the art of the lime-burner, lime-ſtone, or carbonate of lime in ſtony maſſes, marble, calcareous ſpar, oyſter-ſhells, &c. are made to undergo a ſimilar change. This art conſiſts intirely in the decompoſition of the ſalt by means of fire. A kiln is conſtructed with pieces of

the lime-ſtone itſelf; between them are left intervals or vacuities, to permit the flame to paſs through and ſtrike upon them on all ſides; a fire is made with wood or coal to heat them; the water, and gaſeous and carbonic acid are diſſipated in the atmoſphere; the operation is continued till the whole of the ſalt is intirely decompoſed, deprived of water and acid, and reduced to its pure baſe; and thus quick-lime is obtained.

E. *Action of Air.*

11. THE carbonate of lime is not altered by the contact of air; it neither loſes nor abſorbs moiſture.

F. *Action of Water.*

12. WATER does not diſſolve the carbonate of lime, in whatever quantity this fluid be employed, or to whatever temperature it be raiſed.

G. *Decompoſition; Proportion.*

13. THE carbonate of lime experiences no alteration from ſeveral combuſtible bodies: charcoal does not promote the evolution of its acid, as it does with reſpect to the carbonates of barites and ſtrontian; or, at leaſt, this property has not been aſcertained.

14. Phoſphorus decompoſes it with the aſſiſtance of a temperature above that of boiling water; phoſphoric acid being formed, which unites with the lime, and oxide of carbon is diſengaged, which ſuddenly blackens the mixture. This remarkable decompoſition is owing to a diſpoſing and double elective attraction, which has been explained at full in the firſt ſection of this article. The reader will recollect, that carbon does not decompoſe the phoſphate of lime.

15. When calcareous carbonate is heated ſtrongly with ſulphur, ſulphuret of lime is formed, and gaſeous carbonic acid is evolved at the moment when the ſulphuret is formed, and melts. In this caſe the carbonic acid gas carries off with it a little ſulphur in the ſtate of vapour, which gives it a fetid ſmell.

16. This ſalt does not attack metallic oxides, and no combination will take place between theſe ſubſtances.

17. All the acids decompoſe calcareous carbonate, and diſengage from it the carbonic acid with effervefcence, in proportion to the caloric ſeparated from the lime and from the acid at the ſame time; ſo that here we find a double attraction takes place, namely, that of the acid for the lime, and that of caloric for the carbonic acid. Accordingly this effervefcence is accompanied with cold, or with no increaſe of temperature; while, if the ſame acids be com-

bined with lime, much heat is produced, or a conſiderable portion of caloric ſet at liberty.

18. The carbonic acid eaſily diſſolves carbonate of lime, and it is in this manner it is diſſolved in all waters that contain it naturally. When this acid is diſengaged from the water by the contact of air, and more eſpecially by the action of caloric, the carbonate of lime ſubſides in the form of powder. This is what takes place in the waters that form incruſtations on bodies wetted by them in the channels through which they paſs, as thoſe of Arcueil near Paris, of Saint Allyre at Clermont-Ferrand, of the baths of San Filippo in Italy, and a number of others. If we add lime-water to this ſolution of calcareous carbonate by carbonic acid, this ſalt will be precipitated from the water. The ſame phenomenon occurs on putting into the ſolution pot-aſh, ſoda, or ammonia, which ſeizes the carbonic acid, and conſequently obliges the carbonate of lime to quit the water, by reſtoring its inſolubility.

19. Barites and ſtrontian decompoſe calcareous carbonate, and deprive it of its acid. The alkalis do not effect a ſimilar decompoſition. Silex and alumine are equally incapable of acting upon this ſalt. With a ſtrong fire they enter into fuſion with its baſe, from which the carbonic acid flies off. Lime itſelf appears to have a ſort of attraction for this ſalt, ſince it effects its ſolution in water, as has been ſaid above.

20. Carbonate of lime has no ſenſible action on moſt of the ſalts: thoſe alone, of which ammonia is the baſe, are decompoſed by it, with the aſſiſtance of a high temperature. The acid of theſe ammoniacal ſalts, in this caſe, attacks the lime, while the carbonic acid unites with the ammonia. The carbonate of ammonia ſublimes in proportion as it is formed, and in its ſlow ſublimation aſſumes an irregular figure. It is thus that carbonate of ammonia is prepared from ammoniacal muriate and calcareous carbonate, as will be ſeen hereafter.

21. According to Bergmann, 100 parts of very pure calcareous carbonate are formed of

Lime	55
Carbonic acid	34
Water	11

H. *Uſes.*

22. The uſes of carbonate of lime are very multifarious. Its hard maſſes, of a fine grain, and ſuſceptible of a poliſh, are employed by the ſculptor: its maſſes leſs fine than the preceding, are uſed for building, under the name freeſtone. Its ſoft, or common ſtones, are made into lime; and there is not one variety of this ſalt which is not deſtined to anſwer ſome purpoſe of induſtry or economy. Chemiſts employ it in a great number of operations.

SPECIES

SPECIES IV.

Carbonate of Pot-Aſh.

A. *Synonymy; Hiſtory.*

1. CARBONATE of pot-aſh was long uſed in chemiſtry and in the arts, without its being properly known and diſtinguiſhed from the vegetable alkali, as it was called. The character of effervefcing with acids, aſcribed to it, evidently proves this. Afterwards Black, Jacquin, Chaulnes, Lavoiſier, Berthollet, and Pelletier, ſucceſſively turned their attention to the properties of this ſalt, and each added ſome additional information to its hiſtory. As early as 1666 Bohnius announced its property of being cryſtallizable; and in 1764, Montet, a chemiſt of Montpellier, had obtained cryſtals of it before its nature was known.

2. Since its characters and compoſition have begun to be ſtudied, it has been called *mild vegetable alkali*, *effervefcent fixed alkali*, *aerated fixed alkali*, *alkaline chalk*, *mephitic tartar*, *mephite of pot-aſh*, ſubſequently to the names of *fixed ſalt of nitre*, *ſalt of tartar*, *fixed nitre*, *white flux*, *fixed alkali*, under which it was known before the diſcovery of the acid which conſtitutes it a ſalt.

B. *Phyſical*

B. *Phyſical Properties.*

3. Carbonate of pot-aſh cryſtallizes in ſquare priſms terminated by quadrangular pyramids. It has a mild urinous flavour: it turns ſyrup of violets green.

4. It has not yet been found in the foſſil kingdom. It is met with in the juices of vegetables; and it is extracted chiefly from their aſhes, particularly in great abundance from thoſe of the tartareous acidule. It is much more rare in animal ſubſtances. Hence we ſee the reaſon why this ſalt, when it was ſuppoſed to be pure fixed alkali, had the name of vegetable alkali given it.

C. *Preparation; Extraction.*

5. When it is extracted from vegetable ſubſtances by incineration and lixiviation, it is never pure. Beſides its not being ſaturated with carbonic acid, it almoſt always contains ſilex, and different ſalts. It is purified by paſſing into its ſolution carbonic acid gas, which is abſorbed.

6. This ſalt is often prepared ſpeedily, and as was formerly ſaid, extemporaneouſly, by detonating together nitre and tartar. The carbonic acid, which is formed in this rapid combuſtion, unites to the pot-aſh that remains, but it never

ſaturates it in the proceſs, and more is obliged to be added afterwards when it is diſſolved.

7. The proceſs of Chaulnes alſo is well adapted to afford carbonate of pot-aſh. It conſiſts in expoſing a pure ſolution of pot-aſh to the carbonic acid gas, evolved from fermenting wort, and ſtirring the liquor well by means of an agitator. Thus the acid is quickly abſorbed; the carbonate of pot-aſh formed cryſtallizes in the middle of the liquor; it is dried in the air on blotting paper, and muſt be kept in bottles cloſely ſtopped.

8. If we have not a brewer's vat at command, we may paſs carbonic acid gas, diſengaged from carbonate of lime by means of ſulphuric acid, into a ſolution of pot-aſh, in tall, narrow bottles. The carbonate of pot-aſh cryſtallizes on the ſurface of the liquor, and round the tubes, which we muſt take care to chooſe of a large ſize, that they may not be ſtopped up by the ſalt. It was thus Pelletier obtained cryſtals of carbonate of pot-aſh in tetrahedral rhomboidal priſms terminated by dihedral ſummits.

9. Citizen Berthollet has given another proceſs for preparing carbonate of pot-aſh. This conſiſts in diſtilling, with a ſolution of the alkali not ſaturated, ſolid carbonate of ammonia, from which the pot-aſh takes the carbonic acid; ſo that the carbonate of pot-aſh cryſtallizes in the retort, while the ammonia is diſengaged in the ſtate of gas, or of cauſtic liquor.

D. *Action of Caloric.*

10. The carbonate of pot-aſh melts with a gentle heat, and afterwards loſes its water of cryſtallization, which is from 0,15 to 0,17. A portion of its carbonic acid is alſo diſengaged; but all its acid cannot be expelled by this proceſs, the laſt portion adhering to it very forcibly, ſo that the action of caloric cannot be employed to make an accurate analyſis of this ſalt.

E. *Action of the Air.*

11. When very pure and well cryſtallized carbonate of pot-aſh is expoſed in contact with dry air, it ſoon becomes covered with a light white duſt, which announces it to be efloreſcent. Yet before chemiſts were acquainted with this ſalt in its ſaturated ſtate, they imagined it was its character to attract the water of the atmoſphere, and denoted it by the name of Deliqueſcent Alkali. When it grows moiſt in the air, it is becauſe it is not ſaturated with carbonic acid, and contains a portion of unmixed or cauſtic pot-aſh, which is extremely ſuſceptible of attracting the atmoſpheric moiſture.

F. *Action of Water.*

12. Carbonate of pot-aſh requires nearly four times its weight of water at the tempera-

ture of 0, to diſſolve it; and, in its diſſolution, cold is produced. When at 75°, or 80° of Reaumur's thermometer, it diſſolves five-ſixths of its weight; yet the ſalt does not cryſtallize by cooling, but only by a ſlow and gentle evaporation. Pelletier obſerved, that, on diſſolving well-ſaturated carbonate of pot-aſh in boiling water, bubbles of carbonic acid gas were diſengaged; which convinced him, that this ſalt loſt a portion of its acid, as the effect of this ſolution by means of heat.

G. *Decompoſition; Proportions of its Principles.*

13. Combustible ſubſtances have no very marked action on carbonate of pot-aſh. It is not known whether carbon has the property of promoting the diſengagement of its acid by heat, or not. On heating this ſalt with ſulphur, at a high temperature, the carbonic acid eſcapes in the ſtate of gas, and a ſulphuret is formed at the very moment of the effervefcence produced by the diſengagement of this acid.

14. Some metallic ſubſtances, heated with carbonate of pot-aſh, experience an oxidation; but this is owing to the water contained in the ſalt, which is decompoſed by the diſpoſing attraction, which the pot-aſh, and even the carbonic acid, exert on the oxide of the metal. But this action is feeble.

15. All the acids hitherto known have the property of decompoſing the carbonate of pot-aſh,

of diſengaging from it carbonic acid gas with effervefcence, and of forming with its baſe, or the pot-aſh, thoſe ſalts which they ordinarily conſtitute. By this decompoſition, and the diſengagement of its volatile acid, the ſalt loſes more than a third of its weight.

16. Barites, ſtrontian, and lime, decompoſe carbonate of pot-aſh, taking from it the acid, and leaving the pot-aſh diſengaged, becauſe they have a ſtronger attraction for the carbonic acid than this fixed alkali has. In making the experiment in the humid way, or mixing theſe ſubſtances in a ſtate of ſolution, precipitates of inſoluble carbonates are formed, and the pot-aſh remains in the ſupernatant water. Lime, as the leaſt expenſive and moſt common, is employed moſt frequently in this important operation, by which pure pot-aſh is obtained. The carbonate of pot-aſh is mixed with half its weight of very ſtrong quick-lime, on which it is ſpread: water is thrown on to ſlack the lime; it is then diluted, and abſorbs the carbonic acid, paſſes to the ſtate of carbonate of lime, which is inſoluble, and the pot-aſh remains pure and cauſtic in the liquor. This proceſs, termed cauſtification, is employed in laboratories for procuring pure pot-aſh. It manifeſtly depends altogether on the attraction that exiſts between the lime and carbonic acid being more powerful than that between the ſame acid and pot-aſh. Under the article pot-aſh I have already ſhown how this operation is performed, and the pro-

perties acquired by the pot-aſh thus purified.

17. Silex and alumine do not act in cold on the carbonate of pot-aſh. If they be heated ſtrongly together, the carbonic acid flies off in gas, and with a briſk efferveſcence, at the moment when the pot-aſh combines with the earths in the ſtate of glaſs. Thus it appears, that theſe vitreſcible earths at a high temperature favour the diſengagement of carbonic acid; and that the double attraction of the alkali for the earth, and of caloric for the acid, effects a complete decompoſition of the carbonate of pot-aſh; which does not take place, as is well known, from the attraction of caloric ſingly. Accordingly, in glaſs-houſes, where pot-aſh partly in carbonic acid is uſed, a conſiderable ebullition is perceived in the pots where the glaſs is made; and it is alſo obſerved, that this efferveſcence muſt ceaſe for the vitrification to be complete. It is likewiſe in conſequence of this property, that lithologiſts employ carbonate of pot-aſh, to diſtinguiſh with the blow-pipe, by means of the efferveſcence and the well-fuſed and tranſparent vitreous globule, ſiliceous ſtones, which alone exhibit theſe properties.

18. The action of carbonate of pot-aſh on ſalts is very different from that of ſimple pot-aſh. In the firſt place, all the calcareous, ſtrontian, ammoniacal, magneſian, and aluminous ſalts, which ſimple pot-aſh decompoſes, and

from which it precipitates or ſeparates their baſes pure, afford, on the addition of the carbonate, more copious precipitates, which are inſoluble carbonates. In this caſe double elective attractions occur, but they are *ſuperfluous* for the purpoſe of the decompoſition, ſince this would be effected by the pot-aſh alone. They muſt be conſidered only as double combinations, the reſults of which are on the one hand ſalts, with baſe of pot-aſh; and on the other, inſoluble carbonates. Thus we obtain the ammoniacal carbonate, which ſublimes, when muriate of ammonia and carbonate of pot-aſh are treated in the dry way in a retort.

19. But the caſes in which the double elective attraction produced by the carbonate of pot-aſh is neceſſary, to effect the decompoſition of certain ſalts, are much more important ſtill than the preceding. Salts, with barites for their baſe, particularly belong to this claſs. Pot-aſh alone does not ſeparate this baſe, which adheres ſo ſtrongly to acids: but the attraction of the carbonic acid for barites, added to that of pot-aſh for the acid, which holds the barites diſſolved, effects the ſeparation. Accordingly, on pouring a ſolution of carbonate of pot-aſh into a ſolution of nitrate or muriate of barites, a copious precipitate of carbonate of barites in the form of a white powder enſues, and the ſupernatant liquor retains nitrate or muriate of pot-aſh. Thus the artificial carbonate of barites is

prepared. The ſame phenomenon takes place in the dry way; and this is particularly employed for decompoſing the ſulphate of barites, which is not ſoluble, by dry carbonate of pot-aſh. A great quantity of the latter is requiſite in this proceſs; it is alſo neceſſary to heat the mixture ſtrongly; and even then only a portion of the ſulphate will be decompoſed; and we are obliged to repeat the operation ſeveral times following. On lixiviating the product heated to the point of fuſion, a ſolution of ſulphate of pot-aſh will be obtained, and carbonate of barites in powder will remain, frequently mixed with ſulphate of barites not decompoſed.

20. According to Bergmann, the carbonate of pot-aſh contains, in a hundred parts,

Pot-aſh	48
Carbonic acid	20
Water	32

According to Pelletier, a hundred parts of this ſalt thoroughly ſaturated, have the following proportions:

Pot-aſh	30
Carbonic acid	43
Water	17

The latter chemiſt appears to have ſaturated the pot-aſh more completely with carbonic acid.

H. *Uſes.*

21. THE uſes of carbonate of pot-aſh in chemiſtry are very numerous. In medicine this ſalt is conſidered as attenuant, and even lithontriptic; but very improperly and erroneouſly. When we wiſh to adminiſter it, we ſhould preſcribe it only in the ſtate of very regular cryſtals. In the arts it is never employed very pure: it is commonly a mixture of pot-aſh, and carbonate of pot-aſh, that is uſed in glaſs-houſes and by dyers. This ſaline ſubſtance being pretty ſcarce in ſome countries, and conſequently more or leſs valuable, it may be huſbanded much more than is commonly practiſed, by extracting it by evaporation and incineration from lixivia kept after being uſed. In this point a great improvement may be made in manufactories, where this ſubſtance is inconſiderately waſted.

SPECIES V.

Carbonate of Soda.

A. *Synonymy; Hiſtory.*

1. NATURALISTS had long known the carbonate of ſoda, and it had been long in uſe, before it was accurately diſtinguiſhed from ſoda itſelf; for, without appreciating it with preci-

ſion,

ſion, they had at leaſt diſtinguiſhed the very different ſtate of this ſalt, after having extracted it from crude ſoda by lixiviating this with water, chiefly by its cryſtalline form, and by its efflorefcence. This diſtinction particularly led to the difference obſerved between the ſalt of ſoda and the alkali of pot-aſh, &c. At the period when Black diſcovered the ſtate of alkalis rendered mild by *fixed air*, or carbonic acid; this difference was inſtantaneouſly ſeen.

2. From that period to the eſtabliſhment of the methodical nomenclature, the names of this ſubſtance, then placed in the claſs at leaſt of compound, if not of neutral ſalts, have changed like thoſe of the other carbonates. It has been called *aerated, marine, or mineral alkali, chalk of ſoda, mephite of ſoda, natron, ſalt of ſoda.*

B. *Phyſical Properties.*

3. CARBONATE of ſoda is found abundantly in nature. It efflorefces on the ſurface of the ground in Egypt, where it has been known from time immemorial under the name of *nitrum, natron,* or *natrum;* and hence it has been propoſed to retain the laſt-mentioned name, even ſince our more accurate knowledge of the nature of this ſalt, which bore it from the moſt remote antiquity. In the Delta, where it is ſo abundant, it appears to originate from the decompoſition

compoſition of ſalt or muriate of ſoda, diffuſed through layers of vegetable and animal mud, and no doubt promoted by the pot-aſh which the ſpontaneous decompoſition of the vegetables furniſhes.

4. Carbonate of ſoda is obſerved efflореſcent in ſome dry cellars, or places built underground. It is extracted from the aſhes of ſome marine plants, particularly from that whence it has received its name. Theſe plants are burned; their aſhes are calcined in a ſtrong fire, till they begin to vitrify; and what is prepared in this way in the great under the name of ſoda, is a mixture of different ſalts, earths, ſand, charcoal unburned, and oxide of iron in different ſtates, with more or leſs alkali of ſoda ſaturated with carbonic acid. This preparation muſt neceſſarily vary according to the plants employed, the manner in which they are burned, the ſoil where the incineration is made: it contains more or leſs carbonate of ſoda; and as this ſpecies of alkali demands leſs carbonic acid to ſaturate it to the degree of a true carbonate than pot-aſh requires, the ſalt is obtained pure and cryſtallized directly from crude ſoda by ſimple lixiviation. On this account the carbonate of ſoda was in fact known long before the carbonate of pot-aſh, and called ſalt of ſoda.

5. It has not yet been explained how marine plants, and particularly the *ſalſola of ſoda* of Linné, afford ſoda. From the analyſis of Citizen Vauquelin, a portion of alkaline ſalt ap-

pears to be contained in them already formed; but it may be preſumed, that another portion is ſeparated from the marine ſalt with which the juices of theſe plants are impregnated, by means of the pot-aſh which the combuſtion develops. It is to be obſerved, that the algæ and fuci burned in ſome countries, particularly at Cherbourg, afford much leſs ſoda than the ſalſolas, or kalis, as they are alſo called.

6. Carbonate of ſoda exiſts likewiſe diſſolved in ſome mineral waters. Thoſe of Vichy, and many others, particularly in the neighbourhood of Clermont-Ferrand, contain a quantity ſufficiently great, not only to impart to them very efficacious medicinal properties, but even to enable this uſeful ſaline ſubſtance to be extracted from them with advantage for the purpoſe of commerce.

7. The carbonate of ſoda is found alſo in the animal fluids, and even in the bones, much more frequently than the carbonate of pot-aſh, which is met with only in certain particular caſes, or in ſome particular fluids.

8. The carbonate of ſoda cryſtallizes in irregular or rhomboidal octahedra, formed by two quadrangular pyramids truncated very near to their baſes, which exhibit ſolid decahedra, having two acute and two obtuſe ſolid angles. Frequently it yields only rhomboidal laminæ applied on one another obliquely. Its ſavour is urinous, and a little acrid, without being cauſtic, and it turns green ſuch blue vegetable co-

lours as are ſuſceptible of this change: theſe two properties ſhow that ſoda, though ſaturated with as much carbonic acid as will combine with it, has not its alkaline qualities completely maſked.

C. *Preparation; Purification.*

9. The natural ſtate of ſaturation of ſoda by the carbonic acid, and that of carbonate of ſoda which exiſts in the ſoda of the ſhops, allow it to be extracted tolerably pure from this ſubſtance, as has been already ſaid. For this it is ſufficient to lixiviate with a fourth, or, at moſt, a third, of pure cold water, ſoda well choſen, and which has been left for ſome time to effloreſce in dry air, in order to ſeparate the carbonate from the ſubſtances mixed with it; to filter this liquor, to evaporate it, till it forms a ſlight pellicle compoſed of little cubes, which are muriate of ſoda; to ſkim off this ſalt with a ladle, or ſeparate it by means of a hair ſieve plunged in the liquor, and taken out from time to time; to continue the action of the fire till no more marine ſalt is formed; and then to let the liquor cool. The carbonate of ſoda cryſtallizes on its cooling, and thus even affords very regular cryſtals.

10. The facility with which very pure carbonate of ſoda may be procured, renders it unneceſſary ever to prepare it by art: and it would be altogether ſuperfluous to take cauſtic

ſoda for this purpoſe, and ſaturate it with carbonic acid, ſince cauſtic ſoda is procured only from the carbonate of this baſe extracted immediately from ſoda.

D. *Action of Caloric.*

11. The carbonate of ſoda is affected differently from that of pot-aſh when expoſed to the action of fire. It melts very quickly by means of its water of cryſtallization, which is in great abundance, after which it dries: but it is not long before it undergoes the real igneous fuſion, if the heat be continued. Though it may be deprived of the greater part of its carbonic acid by a ſtrong heat, it is with very great difficulty the laſt portions of it are expelled. On comparing its fuſibility with that of carbonate of pot-aſh, it is obſerved to be a little more eaſy, and a little more diſtinct; on which account the former is frequently preferred to the latter in glaſs-houſes.

E. *Action of the Air.*

12. There is a very ſtriking difference between the two alkaline carbonates in the manner in which they are acted upon by the air. It has been ſeen that the carbonate of pot-aſh is ſcarcely altered by it, barely experiencing a ſlight efflorefcence when it is in ſmall, badly-formed cryſtals. The carbonate of ſoda, on

the contrary, when beſt cryſtallized, and in the largeſt cryſtals, very ſpeedily loſes its water of cryſtallization in the air, rapidly effloreſces, and falls to powder, even to the laſt cryſtalline particle. This ſalt is indeed one of the moſt efflorescent known; and this property depends on the great quantity of its water of cryſtallization, the greater part of which the air takes from it with ſingular energy. Its former regular figure, tranſparency, and ſolidity, will be re-produced by reſtoring the water of which it was deprived by the air.

F. *Action of Water.*

13. The carbonate of ſoda is more ſoluble in water than the carbonate of pot-aſh, ſince it requires only two parts at the temperature of 10°, while the latter requires four. Boiling water diſſolves a little more than its own weight, ſo that it cryſtallizes on cooling, though a much more regular cryſtallization is obtained by ſlow or ſpontaneous evaporation.

G. *Decompoſition; Proportions.*

14. This ſalt greatly reſembles carbonate of pot-aſh in the laws and phenomena both of its own decompoſition, and of that which it produces on other ſaline ſubſtances. Carbon has no action upon it with which we are acquainted. With ſulphur it unites at a high temperature,

loſing its carbonic acid, which is diſengaged with a briſk effervefcence at the moment when the ſulphur is formed. It does not act perceptibly on metallic ſubſtances, except ſuch as are eaſily decompoſed by water.

15. This, and the carbonate of lime, are more decompoſable by phoſphorus than any other ſalt of the genus. At the inſtant when this combuſtible ſubſtance, becoming volatile, traverſes the carbonate of ſoda, previouſly heated, as is done in the tube which I deſcribed in the hiſtory of the carbonic acid, all the white maſs of ſalt is found to be blackened. On breaking the tube when cold, into which the carbonate of ſoda was put in powder, a black agglutinated maſs is found, nearly of one ſingle piece, and as ſolid as ſoft friable coal; which, being lixiviated with hot water, leaves a reſiduum of charcoal in very fine powder, and almoſt pure, while the phoſphate of ſoda is diſſolved by the water. The facility of this decompoſition has induced modern chemiſts to chooſe this ſaline ſubſtance for ſhowing the action of heated phoſphorus on carbonates.

16. All the acids, even the boracic acid aſſiſted by heat, decompoſe the carbonate of ſoda, diſengaging the carbonic acid with effervefcence, while they ſeize on the ſoda: the caloric thus ſeparated diſſolves the carbonic acid into gas, and the decompoſition is accompanied with a decreaſe of temperature proportionate to this abſorption of caloric; which proves that the

weakneſs of this acid is owing to its extreme ſolubility in caloric, and to the ſingular tendency it has to aſſume the gaſeous form.

17. Barites, ſtrontian, lime, and pot-aſh, take the carbonic acid from ſoda, and leave this alkali ſeparated and uncombined. The ſolution of theſe three baſes, more attractable than ſoda by the carbonic acid, form in the ſolution of carbonate of ſoda a precipitate of inſoluble carbonate. To obtain pure ſoda from this ſalt lime is uſed, and exactly the ſame proceſs is employed as with the carbonate of pot-aſh.

18. Silex and alumine, which do not act cold and in the humid way on the carbonate of ſoda, combine with its baſe, and convert it into the vitreous ſtate by the aſſiſtance of heat. On this occaſion, as in the ſimilar treatment of the carbonate of pot-aſh, the carbonic acid flies off in gas, and with a briſk effervefcence, at the moment when the earth melts with the ſoda; and the cauſe of this phenomenon is the double affinity of the ſilex or alumine for the ſoda and of caloric for the carbonic acid. In fact the laſt has a tendency to aſſume the form of gas through the means of the caloric, while the ſoda itſelf tends to remain in a ſolid, fixed, and vitreous ſtate, uniting with the one or the other of the earths we have mentioned.

19. With the ſalts carbonate of ſoda comports itſelf in the ſame manner as the carbonate of pot-aſh. Salts, with baſe of lime, ammonia, or magneſia, are inſtantly decompoſed and

precipitated in earthy carbonates, while the very ſoluble ſalts of ſoda remain in the ſupernatant liquor. But here a *ſuperfluous* double elective attraction takes place, ſince the decompoſition would be effected by ſoda alone, which has a greater affinity for the acids than the earths or baſes mentioned.

20. On the contrary, a true, or *neceſſary* double elective attraction is diſplayed, when the baritic ſalts are treated with carbonate of ſoda. There is a complete decompoſition at the inſtant we pour a ſolution of carbonate of ſoda into ſolutions of ſuch of theſe ſalts as are ſoluble, the nitrate and muriate of barites for inſtance; or when we heat in crucibles the inſoluble baritic ſalts, the ſulphate, phoſphate, or fluate of barites, with three or four times their weight of carbonate of ſoda. To give the explanation and circumſtances of theſe phenomena, would only be to repeat what was ſaid in the preceding ſpecies, except one eſſential remark which muſt not be omitted, that the affinity of the carbonic acid acts an important part in this experiment, ſince that of ſoda for the acids, united to the barites, is weaker than that of pot-aſh.

21. According to the analyſis of Bergmann, which I found to be accurate by my own experiments, the reſults of which gave me no difference from thoſe of the celebrated Swediſh chemiſt worth notice, a hundred parts of carbonate of ſoda contain, of

Soda	20
Carbonic acid	16
Water	64

It is to be obſerved, that this carbonate contains more carbonic acid than pot-aſh, which depends on its weaker attraction; for it is a general rule in chemiſtry, particularly with regard to the ſalts, that the more weak the component principles are, the more they require reciprocally for their ſaturation; the more of the baſe if we conſider the acids, the more of the acid if we conſider the baſes. The truth of this principle may eaſily be verified by comparing together the attractions and proportions of the principles that conſtitute the ſalts hitherto examined.

H. *Uſes.*

22. Carbonate of ſoda is one of the moſt uſeful of the ſalts to chemiſts. It may be preſcribed in medicine as the carbonate of pot-aſh. In the arts likewiſe it is among the ſubſtances moſt frequently employed. It is uſed particularly in glaſs-houſes, where it is preferred to the carbonate of pot-aſh as a better ſolvent; and in ſoap manufactories, where it is decompoſed by lime, and forms hard ſoaps. It enters into the preparation of dyes and lixivia, and of many pharmaceutical compoſitions or mixtures. Mineralogiſts employ it with the blow-pipe as a ſolvent, and it conſtitutes an eſſential ingredient in their examinations of foſſils.

SPECIES VI.

Carbonate of Magneſia.

A. *Synonymy; Hiſtory.*

1. THE carbonate of magneſia, called ſucceſſively *mild magneſia, effervеſcent magneſia, aerated magneſia, mephite of magneſia, chalk of magneſia*, could not be ſaid to have been known before the period when Black diſtinguiſhed the alkaline ſubſtances, united with fixed air, from thoſe which are deprived of it. It is even one of the ſubſtances in which that learned philoſopher, who made this acid the object of his reſearches, firſt noticed its preſence. Bergmann afterwards examined it with care; and, laſtly, I added ſeveral notions reſpecting the properties of this earthy ſalt, which had eſcaped the chemiſts that preceded me in this career. There is no ſaline ſubſtance more accurately determined and ſtudied with regard to its character than this.

B. *Phyſical Properties; Natural Hiſtory.*

2. THE carbonate of magneſia is frequently in the form of a white powder, light, taſteleſs, and void of acrimony, and ſometimes agglutinated into a ſort of cakes ſomewhat reſem-

bling ſtarch. This ſalt, however, is capable of aſſuming a regular cryſtalline form. I was the firſt who obtained and deſcribed its cryſtals, which are ſmall priſms with eight regular rhomboïdal ſides, truncated obliquely at their extremities, or rather without pyramids: the plane cuts the axis of the priſms obliquely. In this form it is well ſaturated with carbonic acid, while, in powder, it does not contain the quantity neceſſary to prevent its abſorbing more; ſo that, conſequently, in the latter form, it does not poſſeſs the complete properties of the ſalt. The cryſtallized carbonate of magneſia is of a tolerable conſiſtence.

3. It has not yet been found in nature, or met with in foſſils, though it is probable that it does exiſt in them, and form ſome tranſparent cryſtalline ſubſtance, hitherto, perhaps, confounded with ſome variety of what is called calcareous ſpar. The fact that ſeveral varieties of carbonate of lime in the form of chalk, depoſitions, incruſtations, marble, &c. are ſometimes mixed with a certain quantity of pulverulent carbonate of magneſia, which is demonſtrated by chemical analyſis, affords particular grounds for this ſuſpicion.

C. *Preparation.*

4. For want of native carbonate of magneſia, which is not yet known, this ſalt is prepared artificially by mixing a ſolution of ſul-

phate of magneſia with a ſolution of carbonate of pot-aſh, which does not immediately afford a precipitate, but which yields at the expiration of a few hours, and in proportion as the liquor loſes the carbonic acid, which held it in ſolution, carbonate of magneſia in brilliant and very regular cryſtals, or priſms of ſix equal ſides.

5. It may be equally obtained by diſſolving pure magneſia in water impregnated with carbonic acid, and expoſing this ſolution to the air: in proportion as the acid evaporates, the ſalt is depoſited in tranſparent priſms, as in the preceding inſtance. Theſe cryſtals are ſeveral millimetres in length, and very eaſily recognized by the naked eye.

6. It is not ſaturated carbonate of magneſia, but merely magneſia united in part with carbonic acid, that is precipitated under the ordinary circumſtances in laboratories, particularly for pharmaceutic uſe. The following proceſs ſucceeds beſt for obtaining carbonate of magneſia in the non-ſaturated and pulverulent ſtate. One part of the pot-aſh of the ſhops is diſſolved in two parts of water. This is expoſed to the atmoſphere for ſome months, that it may become ſaturated with carbonic acid, and purify itſelf by the depoſition of the ſilex it contains. On the other hand an equal weight of ſulphate of magneſia is diſſolved in four or five times its weight of water, and fifteen parts of water are added to this ſolution after it has been filtered. This liquor is ſet over the fire, and when it

boils, the ſolution of pot-aſh is poured into it; the precipitate of carbonate of magneſia ſubſides; the carbonic acid, which would have diſſolved it if cold, is diſengaged with effervescence as it ſeizes the free caloric; the mixture is well ſtirred and filtered, and the precipitate is waſhed with boiling water to free it from any extraneous ſalt; the earthy carbonate is left to drain, and ſpread in thin layers on paper, which is carried to the drying ſtove; and this ſubſtance, when dry, is in white friable pieces, or a fine powder, that adheres to the ſkin. Such is the preparation of the magneſia uſed in medicine, or of the carbonate of magneſia not ſaturated with acid.

D. *Action of Caloric.*

7. The cryſtallized carbonate of magneſia, when expoſed to the fire in a crucible, decrepitates ſlightly, loſes the water and the acid which it contains, and falls to powder. In this way the ſalt loſes 0,75 of its weight; that which is not ſaturated, and which is called common magneſia, does not experience an equal loſs. When it is calcined in the great, it is agitated, and ſeems to boil, by the diſengagement of the carbonic acid gas. A ſmall portion of this ſalt is carried off in a kind of vapour, which depoſits a white powder on cold bodies. In a dark place, and towards the end of the operation, the magneſia ſhines with a blueiſh phoſphoric

light. In this calcination the carbonate of magneſia loſes about half its weight. The magneſia remains pure, after having undergone the action of fire.

E. *Action of the Air.*

8. THIS ſalt, when cryſtallized in regular tranſparent priſms, very ſpeedily loſes its tranſparency by expoſure to the air. It becomes covered with a white powder, which adheres to the ſalt, and defends its interior ſtrata. It loſes thus about an eighth of its weight. The non-ſaturated pulverulent carbonate of magneſia experiences no alteration from the air.

F. *Action of Water.*

9. THE cryſtallized carbonate of magneſia diſſolves in forty-eight times its weight of water, at ten degrees. That which is pulverulent and non-ſaturated requires more than ten times this proportion of water, at the ſame temperature, to diſſolve it, and firſt forms a paſte with a ſmall quantity of the liquid. When the ſolution of the cryſtallized ſalt is evaporated ſlowly by a gentle fire, ſmall needles are obtained; if it be ſuffered to evaporate ſpontaneouſly in the air, it will yield the hexahedral priſms mentioned above.

G. *Decompoſition; Proportions.*

10. THE carbonate of magneſia is not perceptibly altered by combuſtible ſubſtances. Charcoal does not promote the diſengagement of its acid, which is eaſily effected by the action of fire alone. Phoſphorus decompoſes its acid very difficultly; ſulphur does not unite with it, and does not form a ſulphuret with its baſe.

11. All the acids eaſily decompoſe it, and diſengage its carbonic acid with a briſk and ſpeedy effervefcence. Butini fancied he obſerved, that every acid diſengaged a different quantity of gas; but it was becauſe the acids, being diluted with more or leſs water, in his experiments, different proportions of the carbonic acid were held in ſolution in the liquor. In theſe decompoſitions magneſian ſalts are formed.

12. Carbonic acid was reputed, from the experiments of Bergmann and Butini, to have the property of rendering carbonate of magneſia ſoluble. But as they were unacquainted with this ſalt in its ſaturated and cryſtallized ſtate, it appears, from the proportions of the ſolution given by them, that their water impregnated with carbonic acid did not diſſolve as much magneſia, as water without acid would diſſolve of carbonate of magneſia fully ſaturated. On this ſolution, containing from a ſixty-eighth to a two hundred and eighty-eighth of

its weight of carbonate of magneſia, Butini has made an intereſting obſervation, particularly on the latter ſtate of the ſolution. On heating it the ſalt ſeparates and is precipitated; but it re-diſſolves in cooling. It was in this ſtate the two chemiſts abovementioned, Bergmann and Butini, ſaw the firſt rudiments of carbonate of magneſia cryſtallized by a ſlow and well-conducted evaporation.

13. Barites, ſtrontian, lime, pot-aſh, and ſoda, decompoſe the carbonate of magneſia, and take from it the carbonic acid, for which they have a greater affinity. If ſolutions of theſe baſes be added to that of magneſia by carbonic acid, the magneſia is ſeparated in a pure ſtate. Ammonia does not produce the ſame effect: when this is added to a ſolution of carbonate of magneſia, it ſeparates the ſalt in an efferveſcent ſtate. In fact it will be ſeen, that magneſia decompoſes the carbonate of ammonia, renders the latter cauſtic, and ſubſides as carbonate of magneſia to the bottom of the liquid in which this mixture is left. This is the reaſon why I place the carbonate of magneſia before that of ammonia.

14. Carbonate of magneſia decompoſes baritic, ſtrontian, and calcareous ſalts diſſolved in water, by neceſſary double attractions. The magneſia ſeizes their acids, and the baſes ſubſide in combination with its acid, as is proved by their increaſe of weight, inſolubility in water, and property of efferveſcing with acids.

15. According to Bergmann's analyſis, the moſt ſaturated carbonate of magneſia contains,

Magneſia	45
Carbonic acid	30
Water	25

Butini, however, informs us, that this ſalt prepared for pharmaceutic purpoſes, when conſequently it ſhould contain leſs acid, is compoſed of the following proportions:

Magneſia	43
Carbonic acid	36
Water	21

I have found that well-cryſtallized carbonate of magneſia, obtained by the proceſs deſcribed in No. 4 of this article, much more ſoluble than that of Bergmann and Butini, and ſuſceptible of efflorеſcence in the air, contained in a hundred parts,

Magneſia	25
Carbonic acid	50
Water	25

That which is prepared for the uſe of the ſhops, and not ſaturated, afforded me the following proportions:

Magneſia	40
Carbonic acid	48
Water	12

(See Annal. de Chim. tom. ii. p. 278—299.)

16. Carbonate of magneſia is prepared in the laboratory of the chemiſt only for the purpoſe of exhibiting its properties and affinities. In the arts it is not yet employed. In medicine,

that which is not completely ſaturated is given as a gentle laxative or purgative. This is not the preparation that ſhould be uſed in caſes where the indication is to abſorb acidities in the firſt paſſages. Macquer has juſtly obſerved, that the gaſeous carbonic acid, diſengaged in the ſtomach by the action of the more powerful acid it contains, diſtends that viſcus, fills it with wind, and may occaſion much miſchief. This, no doubt, is the cauſe of the acute pains ſometimes experienced by thoſe who have imprudently taken this kind of medicine when they had an acid generated in the ſtomach. In this caſe, magneſia calcined, and deprived of its carbonic acid, ſhould be adminiſtered; by which all the evils, pains, nauſea, and oppreſſion, to which it may give riſe, will be avoided. It ſhould be preſcribed in the calcined ſtate, alſo in caſes of perſons poiſoned by the mineral acids, and ſeveral other deleterious ſubſtances, in which experience has proved it to produce very good effects. Sometimes, too, it may be employed diſſolved in water by means of carbonic acid, but to anſwer indications different from the preceding.

SPECIES VII.

Carbonate of Ammonia.

A. *Synonymy; Hiſtory.*

1. WE have long been in poſſeſſion of this ſalt, which has been prepared by chemiſts under the names of *Engliſh volatile ſalt*, becauſe it was firſt made in England, and *concrete volatile alkali*, becauſe, having a very ſenſible, though weak ſmell of ammonia, it was thought proper to diſtinguiſh it on account of its form and ſolidity from the cauſtic or volatile fluor alkali, which could be obtained only in a liquid ſtate. But notwithſtanding this nominal diſtinction, chemiſts had no idea of its different nature and compoſition before the diſcovery of Black. The preſence of *fixed air*, or carbonic acid, being once recognized in this ſalt, and confirmed by the inveſtigations of Bergmann, and Chaulnes, Lavoiſier, &c. not only was all obſcurity reſpecting the formation of the pretended volatile fluor alkali, which had been taken to be the foregoing, altered or changed by lime, removed, but new light was inſtantly thrown on a number of chemical properties belonging to ſaline ſubſtances, and all the errors previouſly committed reſpecting their reciprocal attractions and decompoſitions were diſſipated.

It may be affirmed, that the diſcoveries relating to the nature of this ſalt, and its effects in chemical phenomena, have eſtabliſhed a very perſpicuous line of demarcation between all that had been done before, and all that has been done ſince; ſo that moſt of the ancient aſſertions of chemiſts concerning the volatile alkali in its two ſtates, are actually ſo many miſtakes, which modern diſcoveries have taught us to correct.

2. When the compoſition of the ſuppoſed concrete volatile alkali was fully confirmed; when the uniform experience of all modern chemiſts had decided, that it was compoſed of an acid united to the cauſtic volatile alkali, different names were given it, to diſtinguiſh it from the volatile fluor alkali. Bergmann called it *aerated volatile alkali*; and it was named *volatile mephite, cretaceous ammoniacal ſalt, ammoniacal chalk*, according as the acid combined with it was denoted by the appellations of *aërial*, *mephitic*, or *cretaceous*. The term carbonate of ammonia ſucceeded theſe former inexact or incorrect names, at the period when the methodical and ſyſtematic nomenclature was eſtabliſhed.

B. *Phyſical Properties; Natural Hiſtory.*

3. The truly pure carbonate of ammonia is ſeldom very regular in the cryſtalline form. Moſt frequently its cryſtals are ſo ſmall that it

is difficult to determine their figure with accuracy. Bergmann deſcribes and repreſents them as acute octahedra, the four angles of which are truncated. Romé de Liſle has ſeen them in compreſſed tetrahedral priſms, terminated by a dihedral ſummit. Frequently they exhibit little bundles of needles or very ſlender priſms, arranged in ſuch a manner as to repreſent herborizations, fern leaves, or the beards of feathers. Theſe are the moſt uſual product of ſublimation; the truncated octahedron Bergmann obtained by ſaturating warm water with this ſalt, ſtopping the bottle that contained the ſolution cloſely, and expoſing it to a great degree of cold. It is true, he does not expreſs himſelf very determinately reſpecting their form, ſaying, that he obtained only cryſtals of little regularity, which appeared to him to be octahedra, truncated on four of their angles.

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4. The taſte of this ſalt is a little acrid, ammoniacal, and fetid; it diffuſes weakly, but very perceptibly, the ſmell of ammonia; it turns the colour of violets green, and the yellow tint of turmeric brown.

5. It is not found in nature completely formed or pure. It does not exiſt among foſſils; it has not yet been met with diſſolved in waters; it appears to be contained in animal ſubſtances, particularly in putrid urine.

C. *Extraction; Preparation.*

6. It is wholly prepared, or artificially fabricated in chemiſtry by a great many different proceſſes. Formerly it was extracted ſolely from dry animal ſubſtances diſtilled in retorts with a ſtrong heat. This product, then called *volatile ſalt* of hartſhorn, of vipers, &c. was entirely formed by the complete decompoſition of the animal ſubſtance; the ammonia, on the one hand, reſulting from the union of azote and hidrogen, and the carbonic acid, on the other, from that of the carbon with oxigen. It was always rendered impure by the animal oil, which was volatilized at the ſame time with the ſalt. Manufacturers frequently avail themſelves of this proceſs, by diſtilling rags, bones, or pit-coal, to obtain the ammonia required for combining with muriatic acid.

7. Carbonic acid gas, mixed with ammoniacal gas over quickſilver, alſo affords carbonate of ammonia, which as has been ſaid elſewhere, at firſt aſſumes the form of a white vapour, and afterward concretes in little bundles of cryſtals; but this mixture is made in too ſmall quantity to be employed for fabricating the ſalt. A more ſucceſsful mode is to expoſe large globes or jars of glaſs, impregnated or wetted with liquid ammonia, in the atmoſphere of carbonic aci gas, which covers wort in fermentation; a the expiration of a few hours the ſides of the

veſſ

veſſels will be covered with well-ſaturated cryſtals of carbonate of ammonia, and, by increaſing the apparatus ſufficiently, large quantities may thus be prepared at once.

8. But the readieſt and moſt commodious method of obtaining ſolid carbonate in abundance, which is moſt commonly practiſed in chemical laboratories, conſiſts in decompoſing ammoniacal muriate by carbonate of lime. For this, one part of the former ſalt, and two of the latter, choſen extremely pure, very dry and powdered, are to be mixed in a glaſs or marble mortar. This mixture is introduced into a ſtone retort, to which a large ballon or a cucurbit of glaſs, is to be adapted as a receiver, which is to be cooled by applying to its outer ſurface cloths dipped in cold water, and frequently renewing them. The retort is heated gradually to a ſtrong red-heat. In this proceſs there is a ſuperfluous double attraction. The lime, which alone would decompoſe the muriate of ammonia, ſeizes the muriatic acid; and the ammonia, which is ſeparated from it, attacking the carbonic acid diſengaged at the ſame time from the lime, forms ammoniacal carbonate, which ſublimes and adheres in cryſtals to the ſides of the receiver. It is eſſentially neceſſary that the ſubſtance employed be very dry, for without this precaution no dry carbonate of ammonia, or at moſt very little, would be obtained; but it would paſs over in a thick ſolution, from which part would precipitate on cooling. After this

F. *Action of Water.*

12. The carbonate of ammonia is very ſoluble in water, and produces a conſiderable degree of cold during its ſolution. Two parts of water, at ten degrees, diſſolve a little more than one of the ſalt; water, at forty degrees, diſſolves more than an equal weight; and when this ſolution is quickly and powerfully cooled, the ſalt cryſtallizes, and exhibits the appearance of the regular figure deſcribed by Bergmann. Boiling water ſhould not be employed in this proceſs, becauſe the carbonate of ammonia flies off with its vapour.

G. *Decompoſition; Proportions of Principles.*

13. No combuſtible ſubſtance has any action on the carbonate of ammonia, the heat neceſſary to favour ſuch action volatilizing the ſalt before it can take place; accordingly its carbonic acid is not diſengaged by charcoal, and it is not decompoſed by phoſphorus.

14. It appears that ſome metallic oxides can deprive it of its carbonic acid. All the acids, even the boracic, aſſiſted by heat, diſengage its acid with a more marked effervеſcence than that of the carbonates of pot-aſh and ſoda, becauſe it contains more acid than the two laſt, as will preſently be ſeen. The theory of this decompoſition is very ſimple, and the ſame with that of the decompoſition of the carbonates al-

ready examined. The only difference conſiſts in the effervefcence, which here exhibits bubbles much larger, and in greater abundance, than in the caſe of the two preceding ſalts, in conſequence of the greater quantity of carbonic acid.

15. Barites, ſtrontian, lime, pot-aſh, and ſoda, decompoſe carbonate of ammonia in a manner the reverſe of that of the acids, ſince theſe baſes ſeize the acid, and ſet the ammonia at liberty. In the dry way they all exhibit the ſame phenomena, a diſengagement of ammoniacal gas, and formation of carbonates. Even magneſia produces an equal effect by the help of a little time, according to the obſervation of Bergmann, which has led me to place the carbonate of magneſia before that of ammonia. Pot-aſh and ſoda decompoſe carbonate of ammonia without any apparent precipitation; only the former cryſtallizes into carbonate of potaſh, if the ſolutions were ſaturated. Barites, ſtrontian, and lime, form copious precipitates of earthy carbonate. The other baſes, ſilex, alumine, zircone, have no action on this ſalt. Its ſolution diſſolves glucine well, and in abundance; and carbonate of ammonia is ſucceſsfully employed to ſeparate this earth from alumine, in analyzing ſtones that contain both, as it was by Citizen Vauquelin in his analyſis of the beryl and the emerald. The ſolution of glucine, in liquid carbonate of ammonia, lets fall the earth on being expoſed to the action of

heat, in proportion as the carbonate of ammonia is volatilized.

16. Carbonate of ammonia decompoſes the aluminous and zirconian ſalts by a ſuperfluous double affinity, as ammonia alone would effect the ſame decompoſition. It acts in part only on the magneſian ſalts, with which we know triple ſalts are formed by the ammonia. It decompoſes the baritic, ſtrontian, and calcareous ſalts, by a neceſſary double affinity; for ammonia produces no alteration in theſe ſalts, and it effects their decompoſition in this caſe only through the help of the affinity which the carbonic acid has for their earthy baſes. Accordingly, in theſe operations, carbonates of barites, ſtrontian, or lime, are precipitated, though ſometimes no precipitate is occaſioned in the ſolution, on account of the great quantity of carbonic acid this ſalt contains, which diſſolves the carbonate of barites that is formed. It was formerly ſuppoſed, that volatile alkali, had a greater affinity to the acids than the calcareous earth, becauſe the carbonate of ammonia was conſidered as true volatile alkali; while at the ſame time it was ſeen, that the ammoniacal ſalts were decompoſed by lime: this led to the notion of *reciprocal affinities.* We now know by what error chemiſts were long miſled from their ignorance of the carbonic acid, and how greatly it embarraſſed their explanations.

17. According to Bergmann, a hundred parts of carbonate of ammonia well cryſtallized contain:

Carbonic

Carbonic acid	45
Ammonia	43
Water	12

H. *Uſes.*

18. CARBONATE of ammonia is frequently uſeful in chemiſtry for decompoſing other ſalts. In manufactories it is prepared in the great by diſtilling animal ſubſtances for fabricating muriate of ammonia, either by precipitating with it the calcarecus muriate of the bittern in ſalt-works, or by combining it directly with muriatic acid, expelled by the ſulphuric acid from muriate of ſoda.

In medicine, the carbonate of ammonia is frequently adminiſtered as an energetic and powerful remedy. It is uſed as a ſtimulant and ſtrengthener to patients diſpoſed to faint, being given to them to inhale by the noſe. In England, volatile oils are mingled with it, to render it aromatic; and the inſides of little bottles of coloured glaſs, which are kept well ſtopped, are coated with it. It is conſidered as a ſpecific againſt the poiſon of the viper, being taken internally; but moſt of the caſes in which it has been adminiſtered, and where its action was deemed ſpecific, appear to have been of ſuch a nature, that the patients would have recovered ſpontaneouſly, according to the reſults of Mr. Fontana's inquiries. The carbonate of ammonia has been reckoned likewiſe in the number of anti-venereal medicines, and of remedies for cancers; but in both theſe reſpects its virtues are at beſt extremely queſtionable. In general this ſalt is ranked among the detergents, diuretics, diaphoretics, ſtimulants, and attenuants.

SPECIES VIII.

Ammoniaco-magneſian Carbonate.

1. I DISTINGUISH the ammoniaco-magneſian carbonate as a ſpecies, from an [illegible]
which has held good in all the gener
have hitherto deſcribed, and becau
manifeſtly formed on many occa
be not yet able, in the preſent ſtat
ence, to deſcribe the ammoniac
carbonate with as much preciſion a
ceding ſpecies of carbonates, it is i
requiſite to point out the circumſta der
which this ſalt is formed, and to prov reality
of its exiſtence, in order to make the ſyſtematic ſeries of ſaline ſubſtances more complete, and to excite chemiſts to a careful examination of the properties of this new ſpecies, which no author has yet mentioned.

2. When the carbonate of ammonia is decompoſed by means of magneſia, in the moiſt way, by leaving theſe two ſubſtances in contact in a cloſe veſſel, a complete decompoſition i

n

not effected, but an ammoniaco-magneſian triple carbonate is formed. The ſame combination takes place when we precipitate a ſolution of carbonate of magneſia in acidulated water by means of pure ammonia; and alſo when we precipitate a ſolution of ammoniaco-magneſian ſulphate, nitrate, or muriate, by means of carbonate of pot-aſh, or carbonate of ſoda. Thus there are four chemical proceſſes, one of the conſtant products of which is the ſpecies of triple ſalt of which I am here ſpeaking.

3. Though the properties of this carbonate with a double baſe, or combination of two carbonates, are not yet known, I have already ſeen, that it cryſtallizes differently from either of the ſalts which compoſe it; that it follows a diſtinct law of ſolubility and decompoſition; and that it is entirely decompoſable by fire, by the acids, and by barites, ſtrontian, lime, pot-aſh, or ſoda.

SPECIES IX.

Carbonate of Glucine.

A. *Hiſtory.*

1. THE carbonate of glucine is one of the leaſt known ſpecies of this genus, as this ſalt lately diſcovered by citizen Vauquelin, has hitherto been examined only by him, and in very ſmall quantities. It is, however, one of

the ſalts of this new baſe which he has ſtudied, and the properties of which he has beſt aſcertained, becauſe they moſt readily offered themſelves to his inquiries.

B. *Phyſical Properties.*

2. THIS ſalt is in a white, dull, clotty powder, never dry, but ſoft and greaſy to the touch. It is not ſaccharine, like the other ſalts of glucine, but void of taſte. It is very light, and has not yet been found native.

C. *Preparation.*

3. THE carbonate of glucine is prepared artificially, either by expoſing this earth to the air from which it attracts the carbonic acid, or by precipitating ſoluble ſalts of glucine by alkaline carbonates. The precipitate formed is to be well waſhed, to free it from all the extraneous ſalt it may contain, and then thoroughly dried in the open air.

D. *Action of Caloric.*

4. THE action of fire eaſily expels the water and carbonic acid from this ſalt, and reduces it to the ſtate of pure and cauſtic glucine, that is to ſay, to its baſe deprived of acid.

E. *Action of Air.*

5. It is completely unalterable in the air.

F. *Action of Water.*

6. It is inſoluble in water; and, in this reſpect, it even differs from the greater number of other carbonates, which are rendered ſoluble by means of their acid. Citizen Vauquelin could not accompliſh its ſolution in water ſaturated with carbonic acid.

G. *Decompoſition; Proportion of its Principles.*

7. The carbonate of glucine is decompoſable by all the acids of the preceding ſalts, which rapidly expel from it the carbonic acid with a ſtrong and briſk effervefcence, and ſeize upon its baſe.

8. It is decompoſed in the oppoſite mode by the alkalis and alkaline earths, which take from it its acid. Ammonia, firſt decompoſing it, readily diſſolves its baſe, the glucine; becauſe the carbonate of ammonia, formed on this occaſion, has the property of diſſolving this earth eaſily and in abundance.

9. Its action on any of the ſalts hitherto deſcribed has not yet been determined; it muſt be capable of decompoſing the calcareous magne-

ſian, and ammoniacal ſalts, in conſequence of the double affinity of its carbonic acid.

From his firſt experiments on this ſalt, Citizen Vauquelin has concluded that it contains about a fourth of its weight of acid.

H. *Uſes.*

10. THOUGH the little carbonate of glucine hitherto procured has not permitted us yet to endeavour to render it uſeful, it is obvious that it may be employed in chemiſtry, after having been precipitated from a ſoluble ſalt of glucine by an alkaline carbonate, for obtaining this earth pure, ſince it eaſily loſes its acid by calcination.

SPECIES X.

Carbonate of Alumine.

1. THIS is another ſpecies of carbonate yet little examined. If we except the few words ſaid of it by Bergmann in various parts of his works, and what I began to make known reſpecting it in my Elements, chemiſts have hitherto neglected to treat of this ſalt.

2. When we precipitate aluminous ſalts, particularly the triple acidulous ſulphate of alumine, by alkaline carbonates, we find, that the

precipitation is effected without efferveſcence, or with a ſlight efferveſcence, which proves, that the carbonic acid is not evolved: and as it cannot remain combined with the alkali, which is attracted by the ſulphùric acid; it is very evident, that it remains fixed in the precipitated alumine: accordingly the liquor, after this precipitation, contains a portion of true carbonate of alumine, which ſubſides in a few hours, or in a few days, in conſequence of the evaporation of the carbonic acid, which held it in ſolution.

3. Clay, or the native mixture of alumine, ſilex, &c. contains, beſides, a portion of carbonic acid, which is diſengaged by expoſure to a ſtrong fire. That of Cologne, as Bergmann informs us, yields ſeveral times its own bulk of this acid, mixed with a ſmall portion of hidrogen gas. Thus the native alumine of earths appears to be ſaturated with carbonic acid; and it is in conſequence of this, that fat, clayey earths, when treated with acids in order to analyze them, are found to be efferveſcent, even without containing any carbonate of lime, in their aluminous part.

4. No further examination has yet been made of the properties of this combination, which appears, however, neither to affect a cryſtallized form, nor in its characteriſtics to have any thing very diſtinct from pure alumine, for which it is employed, as they are continually confounded

together;

together: as an acidiferous ſubſtance, however, it may act a conſiderable part in vegetation.

Species XI.

Carbonate of Zircone.

1. Mr. Klaproth, who diſcovered zircone to be a peculiar earth, has ſaid nothing of its union with carbonic acid. Citizen Guyton, in his analyſis of the hyacinths of Expailly, imagined, that this earth would not diſſolve in carbonic acid. Citizen Vauquelin, on the contrary, in his comparative analyſis of the French or Expailly hyacinths with thoſe of Ceylon, poſitively aſſerts, that the carbonic acid combines with zircone.

2. It is eaſy to reconcile the two chemiſts on this ſubject. Citizen Guyton employed a very acid ſolution of zircone to be precipitated with alkaline carbonates; and citizen Vauquelin, in his proceſs, uſed muriate of zircone, firſt evaporated, and then re-diſſolved in water. Both too agree, and this conſtitutes a ſtriking ſimilarity in the reſults of their experiments on this head, that zircone, at firſt precipitated by carbonates, re-diſſolves in an exceſs of theſe ſalts; a fact, which proves the attraction of zircone for the carbonic acid.

3. When a ſolution of muriate of zircone is decompoſed by a ſolution of any alkaline carbonate,

bonate, the earth precipitates, without any efferveſcence taking place: which proves, that the carbonic acid unites with the zircone while the alkali combines with the muriatic acid.

4. If the precipitate of zircone thus obtained be collected, and heated in cloſe veſſels, it gives out carbonic acid gas.

5. It affords the ſame product when treated with acids, particularly the muriatic or nitric, both of which diſſolve this earth. The union of zircone with carbonic acid, therefore, and the exiſtence of carbonate of zircone cannot be doubted.

6. From the analyſis of citizen Vauquelin, one hundred parts of this ſalt, from which its acid and its water are eaſily expelled by the action of caloric, contain 55, 5 of zircone, and 44, 5 of water and acid, the proportions of which he has not aſcertained.

7. One of the moſt remarkable characters of the carbonate of zircone, according to the ſame chemiſt, is its combining very eaſily with alkaline carbonates, and becoming very ſoluble with them. It then forms triple ſalts, of which there appear to be at leaſt three ſpecies; namely, a carbonate of pot-aſh and zircone, a carbonate of ſoda and zircone, and a carbonate of ammonia and zircone.

8. Of theſe three ſalts I ſhall treat only of the laſt as a diſtinct ſpecies, becauſe it is the only one of them of which any properties have been noticed by citizen Vauquelin, he having merely announce

announced the exiſtence of the other two; becauſe it would be ſuperfluous to multiply the ſpecies of ſalts; and becauſe it is by no means abſolutely neceſſary to diſtinguiſh all thoſe of which we have barely had a glimpſe, and which would load the ſcience of chemiſtry, without adding to its real wealth, while their characteriſtic properties remain not ſufficiently known.

SPECIES XII.

Ammoniaco-Zirconian Carbonate.

1. WHEN a ſolution of muriate of zircone is precipitated by carbonate of ammonia, at firſt a tolerably copious white precipitate is formed. On continuing to add more of the ſalt, the precipitate diſappears, and the liquor becomes clear. Thus the carbonate of ammonia begins with ſeparating carbonate of zircone, and afterward, when added in exceſs, re-diſſolves it, ſo that an ammoniaco-zirconian carbonate is formed.

2. The experiment juſt deſcribed, is a proof that this triple ſalt is much more ſoluble than the carbonate of zircone; ſince the latter, which at firſt precipitates, afterward re-diſſolves in proportion as it combines with the carbonate of ammonia.

3. The ammoniaco-zirconian carbonate is very eaſily decompoſed by the action of fire. When a ſolution of it is heated over the fire to a ſtate

a ſtate of ebullition, the carbonate of ammonia is volatilized, the liquor becomes milky, and the carbonate of zircone precipitates. To effect this decompoſition completely, it muſt be heated a long time, till all the carbonate of ammonia is volatilized.

4. The fixed alkalis, and the powerful earthy baſes, barites, ſtrontian and lime, decompoſe this ſalt. Citizen Vauquelin remarks, that pure or cauſtic ammonia does not precipitate its ſolution, which in fact it ought not. This remark he advances as a proof, that the ſalt diſſolved is actually a triple ſalt: for, if it were only a ſimple ſolution of carbonate of zircone in an exceſs of carbonic acid, it is very obvious, that the ammonia, taking up this exceſs of acid, would precipitate the carbonate of zircone.

SPECIES XIII.

Ammoniaco-glucinian Carbonate.

1. I HAVE remarked in the hiſtory of glucine, and in that of ſeveral ſpecies of ſaline ſubſtances, that glucine was ſoluble in a lixivium of carbonate of ammonia; and that this property, at the ſame time that it was very uſeful for characterizing this earth, was very advantageous as furniſhing a method of ſeparating it from alumine, which does not diſſolve in this

ammoniacal ſalt as glucine does. This was one of the means that aſſiſted citizen Vanquelin in the diſcovery of glucine, and one of the characters by which he recognized its exiſtence and peculiar nature.

2. This ſolubility of glucine in the lixivium of carbonate of ammonia, while it ſhows a remarkable attraction between the two ſubſtances, proves that the earth participates in the tenacity of ammonia for the carbonic acid; and by this participation, forms a ſpecies of triple ſalt, or ſalt with two baſes, which I call ammoniaco-glucinian carbonate. It is evident that this ſalt, the exiſtence of which is yet new to chemiſts, and no property of which has yet been deſcribed by citizen Vauquelin himſelf, who firſt made it in his experiments, can have none of its peculiar characters known, except its ſolubility in the ſame quantity of water as contained the carbonate of ammonia, with which it is prepared.

ARTICLE XIII.

Review of the general Properties that Salt exhibit, and of the Compariſon that may be made between them.

1. THOUGH the hiſtory of the genera a ſpecies of ſaline ſubſtances, which I have j deſcri

deſcribed, required to be entered into at length, and with conſiderable minuteneſs, to be treated in a manner ſuitable to the preſent ſtate of our knowledge, the reader muſt have perceived, even by the order which I have followed, that it was poſſible to refer their properties to a certain number of general terms, which together, conſtitute the true ſaline character.

2. In fact, the ſavour of ſalts or their impreſſion on our organs of taſte,—the cryſtallization, by means of which art gives them figure, —fuſibility, or the influence which an accumulation of caloric exerts on them,—efflorefcence and deliqueſcence, or the manner in which they are acted upon by air;—and laſtly, their ſolubility or relation to water, are the five moſt deciſive characters of theſe ſubſtances, and, among the properties treated of in this ſection, have occupied the moſt of our attention. To theſe might be added their ſpecific gravity and primitive figure: but we have not yet a ſufficient number of poſitive facts on theſe two properties, to allow us to derive from them general notions, ſuch as I purpoſe to offer in this place. I ſhall not paſs over them in ſilence, however; but it will appear, that they by no means furniſh a compariſon equally uſeful with what I ſhall be able to eſtabliſh on the five properties mentioned above. Each of theſe, therefore, I ſhall proceed to review under a ſeparate head.

SECTION I.

Of the Sapidity of ſalts compared with each other.

3. FORMERLY the taſte was ſuppoſed to be capable of diſtinguiſhing the character and general nature of ſaline ſubſtances. Savour was ſo particularly aſcribed to them, that it ſeemed ſufficient to characterize them, and make them known. In thoſe days, as it was enough for a ſubſtance to be ſapid to be ranked among ſalts, an unlimited number of ſubſtances were referred to this claſs, which poſſeſſed no other property capable of placing them in it; and as no ſaline ſubſtance was thought to be void of ſavour, a great many ſubſtances were excluded from this order, which ought to have made a part of it.

4. Hence that error ſo long committed in mineralogy, by which ſeven or eight principal ſpecies of ſalts continued for ſuch a conſiderable period to be claſſed among ſtones: a fault which has not yet been corrected, except in the modern method adopted by the ſchool of mines in France. Hence too, the practice of ranking acids and alkalis as very acrid ſubſtances in the claſs of ſalts: and even the habit chemiſts had acquired of conſidering theſe acids and alkalis, in conſequence of their very powerful ſapidity, not only as ſalts, but as the ſtrongeſt and moſt

potent ſalts, as thoſe which even imparted their energy to others.

5. At preſent it would be improper to conſider in this manner the relations that taſte bears to ſaline properties. Sapidity cannot continue to be placed at the head of the ſaline characteriſtics, as the ſign of the powerful attraction or affinity it exerts on our organs: this action belongs to other ſubſtances, as much, and often more than to ſalts, for acids and oxides, which are no longer to be conſidered as ſaline ſubſtances, exert it in a much more eminent degree than ſalts.

6. The leaſt reflection on this difference, and on its cauſe, will teach us, that it muſt be owing to the ſtate of the chemical affinities of very ſapid bodies and ſaline ſubſtances compared with each other. The former in fact, have always a great force of combination, becauſe they tend to unite with a great number of bodies: in the ſalts, on the contrary, this force is ſatisfied; the baſes neutralize the acids, according to the ancient language of chemiſtry, that is to ſay, exhauſt their tendency to combination, ſaturate their power of union, and enfeeble the force with which they attack different ſubſtances; the moderns ſay much of the baſes weakened by the acids, where they admit a reciprocal ſaturation. This conſideration, much more preciſe than was formerly adopted in chemiſtry, ſhows that ſalts, far from being the moſt ſapid ſubſtances, muſt on the contray, have the leaſt de-

cided ſavour, as being compounds moſt perfectly ſaturated.

7. It is now eaſy to underſtand, why, in enumerating the properties of moſt ſalts, the expreſſion of perfect inſipidity has been uſed, or a mean ſapidity has been indicated by the ſenſation which is excited in moſt men; a ſavour ſufficiently acrid, ſtrong, and potent to act as a cauſtic, being rarely mentioned. There are, however, among the ſalts, the materials of which adhere together but ſlightly, ſome compounds of a ſtrong and violent taſte: but it is obſervable, that it never extends to cauſticity. It is no leſs remarkable, that the moſt ſtriking inſipidity is frequently found among thoſe ſaline compounds, the component parts of which have the ſtrongeſt ſapidity and greateſt cauſticity in a ſeparate ſtate, as concentrated ſulphuric acid, pot-aſh, ſoda, and barites: and this contraſt, this marked oppoſition, affords a proof, that the attraction reciprocally exerciſed by theſe ſubſtances on each other is the cauſe of their taſte having diſappeared.

8. Although it is a general law in chemiſtry, that compounds have properties very different from thoſe of their component parts, becauſe the attraction of compoſition actually changes the properties of the bodies on which it has acted, there are, however, ſome ſhades of ſapidity, if not ſimilar, at leaſt analogous, ariſing from the combination of a particular acid with different baſes, or of a particular baſe with very different

acids. Thus the nitric acid imparts a coolneſs to nitrates in general; the phoſphoric acid, a ſweetiſh taſte to phoſphates; the ſulphureous, a ſavour of burning ſulphur to ſulphites; the muriatic, a ſaltneſs to muriates. Thus alumine exhibits an acerb or aſtringent ſavour in all ſalts; glucine communicates a ſaccharine taſte to the ſalts compoſed of it; magneſia, a bitter taſte; and zircone, a rough and as it were a metallic taſte. On this fact, however, we muſt not build any point of doctrine, for there are exceptions too numerous, and too ſtrong, for it to be conſidered as general. The ſalts which barites forms are ſome of them inſipid, ſome acrid; yet both are equally deleterious. Lime affords extremely acrid bitter ſalts, and ſalts perfectly void of ſavour.

9. In ſalts, the taſte is frequently found united with other properties, which prettly cloſely follow its weakneſs or ſtrength. Thus it is a general rule, that all very ſapid ſalts are at the ſame time very ſoluble in water; and on the contrary, thoſe which are more or leſs inſipid, have at the ſame time a more or leſs decided inſolubility. It would be difficult to find an exception to this rule: we may even carry it ſo far as to ſay, that the very acrid ſalts are ſo extremely ſoluble, that they powerfully attract the water in the atmoſphere, and are characterized by a ſpeedy deliqueſcence.

10. We find likewiſe a pretty ſtrong analogy, a relation ſufficiently marked, between the ſavours

vours of ſalts and their medicinal properties. There is leſs conſtancy, however, and leſs certainty in this analogy, than in the preceding; or at leaſt it has not been ſtudied with the ſame exactneſs; and it is not ſo eaſy to be known or determined. In general, it is true, that every acrid bitter ſalt is purgative and attenuant; every ſalt that poſſeſſes a bitter ſavour, ~~imparts~~ to water the character of hardneſs: but it muſt not be forgotten, that the ſulphate and carbonate of barites, though perfectly inſipid, are poiſonous.

SECTION II.

Of the Cryſtallization and Form of Salts.

11. CRYSTALLIZATION in chemiſtry ſignifies either the property ſubſtances have of aſſuming a regular form, or the art of making them take it. This form is given them by the help of certain circumſtances, the conjunction of which appears to be neceſſary to favour the arrangement of the molecules. Almoſt all minerals enjoy this property; but there is no ſubſtance in which it acts with ſuch energy, as in thoſe that are ſaline. The circumſtances which favour it, and without which it cannot take place, are reducible, with reſpect to ſalts, to the two following. 1. Their molecules muſt be divided and kept apart by a fluid, that they may afterward

ward tend toward each other, or attract each other reciprocally by thoſe faces which have the greateſt relation to one another. 2. It is neceſſary, that the fluid which keeps their integrant parts ſeparate, ſhould be gradually abſtracted, and ceaſe to keep them apart.

12. From this ſimple expoſition it is eaſy to conceive, that cryſtallization is operated ſolely by virtue of the attraction between the molecules, or the affinity of aggregation, which tends to bring them together, and make them adhere to each other. Theſe conſiderations lead us to imagine, that the integrant parts of a ſalt have a form peculiar to them, and that the different figure which every ſaline ſubſtance affects in its cryſtallization, depends on this primitive form of its molecules. They equally induce us to believe, that the polyhedral figures belong to the molecules of ſalts having unequal ſides, or ſome faces of greater extent than others; theſe molecules muſt have a tendency to approach and unite by thoſe faces which are the moſt extenſive. Suppoſing this, it will be eaſy to conceive, that, on abſtracting the fluid which keeps theſe molecules apart, they will unite by thoſe faces which are beſt adapted to each other, or which bear the ſtrongeſt relation; and if this fluid quit them gradually, and ſo as to leave the ſaline particles time to arrange themſelves, if we may uſe the expreſſion, and preſent themſelves ſuitably to one another, the cryſtallization will be regular; while on the contrary, too ſpeedy an

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SECTION II.

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an abſtraction of the ſeparating fluid will force them to come together ſuddenly, and as we may ſay by the firſt faces that offer, in which caſe the cryſtallization will be irregular, and the figure difficult to be aſcertained. And if the evaporation be altogether ſudden, the ſalt will ever form only a concrete maſs, which will have ſcarcely any cryſtalline appearance.

13. As elements of cryſtallization we muſt alſo conſider the attraction of the ſaline molecules for water and for caloric, and the variations of this attraction, which take place in proportion to the quantity of theſe two fluids compared with that of the ſaline matter; the relation this attraction bears to that which takes place between the molecules of the ſalt, and the difference between theſe two; and laſtly, the attraction of the ſides of the veſſel for theſe molecules. Theſe are ſo many cauſes which give riſe to various ſecondary forms in ſalts, by producing different decrements, more or leſs regular, in the layers of their united molecules.

14. The art of cryſtallizing ſaline ſubſtances is built on theſe fundamental truths. All ſalts are ſuſceptible of it, but with more or leſs facility: there are ſome which cryſtallize ſo eaſily, that we may conſtantly ſucceed in making them aſſume the regular form at pleaſure; others require more precaution and care; and laſtly, there are ſome which it is ſo difficult to obtain in this ſtate, that we have not yet been able to effect it. It is by ſtudying thoroughly the circumſtances pec-

uliar to each ſalt, that we ſucceed in making em cryſtallize. One principal condition for rrying this operation into effect, is to diſſolve he ſaline ſubſtance in water; but there are ſalts ſo little ſoluble by any means we can employ, that it is almoſt impoſſible to procure them to unite afterward in a regular form: ſuch are the ſulphate, carbonate, and fluate of lime, and ſulphate of barites. Nature every day preſents to us theſe earthy neutral ſalts cryſtallized very regularly, but art can imitate her only by the aid of a very long ſpace of time. There are even many diſtinguiſhed natural philoſophers, who do not yet believe the practicability of the proceſs mentioned by Mr. Orchard of Berlin, by means of which he ſays he has produced cryſtals of calcareous carbonate. This ingenious proceſs conſiſts in paſſing water, which has ſtood a long time on ſalts very little ſoluble, through a very narrow gutter, and procuring its evaporation with much ſlowneſs.

15. There are other ſaline matters on the contrary, which are ſo ſoluble, and adhere ſo tenaciouſly to water, that they do not part with it without great difficulty; and it is likewiſe very difficult to obtain them in regular forms. This takes place with all the deliqueſcent ſalts, as the calcareous magneſian nitrates and muriates. It is but with great difficulty that we can ſurmount the attraction theſe ſalts have for water; and if we ſucceed in ſeparating them from it by a great effort, it is only for a few

moments that this ſeparation takes place, for theſe ſalts quickly loſe their cryſtallized ſtate.

16. It cannot be doubted, that every ſalt has its proper and peculiar mode of cryſtallizing; or, which is the ſame thing, that it has in its primary molecules a determinate form, different from that of every other. This unqueſtionably is the firſt cauſe of the remarkable differences that exiſt between the cryſtals obtained. The baſes and acids which conſtitute them, from the ſalino-earthy ſubſtances to the moſt powerful acids, have, for the moſt part, no determinate figure: there are only ſome circumſtances, which, without altogether deſtroying their diſtinguiſhing properties, make them affect a cryſtalline form, as takes place in the oxigenated muriatic acid, and in the concrete ſulphuric. The cauſtic alkalis, however, cryſtallize in laminæ, according to the obſervation of citizen Berthollet; and the acid of borax exhibits the ſame lamellated form to every chemiſt. Moſt of theſe ſalifiable or ſalifiant ſubſtances do not aſſume any regular form in our laboratories, either becauſe they are in fact not ſuſceptible of it, or becauſe our means are inſufficient to give them ſuch a form: but their compounds, the ſalts, all affect a regular form, and art has attained the power of making it diſappear and reproducing it at pleaſure in moſt of them. When we conſider this property, altogether different from what their conſtituent parts poſſeſs, is it poſſible to determine, whether it

depend on the acids, or on the alkaline baſes by which they are neutralized? It appears, that it cannot be aſcribed excluſively to either, for the ſame acids with different baſes, often form ſalts very different in figure; while in other inſtances, the ſame baſe, combined with different acids, exhibits equal diſſimilitude in its cryſtals: it is to the total change of the properties of every new ſaline compound therefore, that the diverſity of forms aſſumed by theſe compounds muſt be attributed.

17. There are three general neans of cryſtallizing ſalts in our laboratories.

A. Evaporation. This proceſs conſiſts in heating a ſaline ſolution, ſo as to reduce the water which keeps apart the molecules of the ſalt into a ſtate of vapour. The more ſlowly this evaporation is conducted, the more regular will the cryſtallization be. It is thus we proceed for obtaining cryſtals of ſulphate of pot-aſh, muriates of pot-aſh and ſoda, ſulphate of lime, and carbonate of magneſia. Their figure has very little regularity, if the water be evaporated too haſtily, as by a boiling heat: but by keeping ſaline ſolutions of this ſort in a ſand-heat of forty-five degrees, or thereabout, very beautiful and very regular cryſtals are conſtantly obtained in a longer or ſhorter ſpace of time; and there is ſcarcely any ſalt which may not be made to aſſume a very diſtinct form by this proceſs, if it be ſkilfully conducted.

B. Refrigeration is ſucceſsfully employed for any but irregular cryſtals, and ſometimes concrete maſſes of no regular form. If we have not yet arrived at the means of cryſtallizing a pretty conſiderable number of neutral ſalts, it is becauſe we have not exactly aſcertained the degree of concentration, to which their reſpective ſolutions ought to be reduced, in order to furniſh cryſtals. This labour, eaſy in itſelf, and requiring nothing but time and patience, has not yet been completely purſued by chemiſts. It is from the ſpecific gravity of ſolutions, that we ſhould obtain theſe data, which would be of great utility to the chemical operator; and this plan has already been adopted with regard to ſaline matters, in ſeveral great manufactories, where an hydrometer is uſed with ſucceſs for determining the point of cryſtallizability for ſaline liquors, as water containing common ſalt, ſalt-petre, alum, &c,

19. Beſides theſe different means of cryſtallizing ſalts, there are ſeveral circumſtances which favour this operation, and the influence of which it is neceſſary to know how to appreciate. A ſlight motion is ſometimes of uſe to bring on the cryſtallization of a ſalt, when it had failed to take place. Thus if we ſhake a capſule filled with a ſaline ſolution, in which no cryſtals appeared, or even remove it to a different place, we ſhall frequently find cryſtallization come on a few moments after the ſlighteſt agitation. I have already remarked, that this phænomenon occurs particularly with the nitrate and muri-

ate of lime. The contact of air ſeems often to be neceſſary to the formation of cryſtals. A ſolution, evaporated to the point requiſite for cryſtallization, many times affords no cryſtals in a bottle cloſely ſtopped, while, if expoſed to the air in a capſule, cryſtals will be ſeen to form in it very ſpeedily. This obſervation was made with great accuracy by Rouelle the elder. The form of the veſſel, and the plunging of foreign bodies into ſaline ſolutions, have alſo much influence on cryſtallization. The firſt of theſe circumſtances affects the figure of the cryſtals, and produces in it a very great variety; for this reaſon threads, or little ſticks, are placed with advantage in the capſules, in which the cryſtallization is performed, for the purpoſe of obtaining regular cryſtals. In this caſe the cryſtals are precipitated on the threads, and as the ſurface on which they repoſe has very little extent, they have commonly the greateſt regularity of figure, while in attaching themſelves to the oblique, irregular, uneven ſides of the earthen pans, or other veſſels commonly employed for this uſe, they are more or leſs truncated and irregular.

The plunging of foreign bodies into ſaline ſolutions, has frequently another advantage; they determine the formation of the cryſtals, which would have been much ſlower without their preſence. Thus a bit of wood, or a ſtone, thrown into a brine ſpring, becomes a baſe, on which the water depoſits cryſtals of muriate of ſoda, any but irregular cryſtals, and ſometimes concrete maſſes of no regular form. If we have not yet arrived at the means of cryſtallizing a pretty conſiderable number of neutral ſalts, it is becauſe we have not exactly aſcertained the degree of concentration, to which their reſpective ſolutions ought to be reduced, in order to furniſh cryſtals. This labour, eaſy in itſelf, and requiring nothing but time and patience, has not yet been completely purſued by chemiſts. It is from the ſpecific gravity of ſolutions, that we ſhould obtain theſe data, which would be of great utility to the chemical operator; and this plan has already been adopted with regard to ſaline matters, in ſeveral great manufactories, where an hydrometer is uſed with ſucceſs for determining the point of cryſtallizability for ſaline liquors, as water containing common ſalt, ſalt-petre, alum, &c,

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ſoda. It is from obſerving this phenomenon that ſome chemiſts have propoſed to throw a ſaline cryſtal into a ſolution of a ſalt, which does not cryſtallize eaſily; and many have aſſerted that this practice favoured the production of cryſtals of ſalts very difficult to be obtained in a regular form. Theſe are the principal cauſes which influence cryſtallization, but no doubt there are others, which future obſervation will make known to chemiſts.

20. The ſeparation of a ſalt from the water which kept it in a ſtate of ſolution cannot be effected in a regular manner, without a part of this fluid being retained by the ſalt. We may convince ourſelves of this, by taking a ſalt reduced to powder by means of heat, as calcined ſulphate of alumine, or borate of ſoda, or dried ſulphate of ſoda, diſſolving it in water, and cryſtallizing it. By this operation we ſhall find the ſalt augmented, and in ſome caſes to double its quantity; that is to ſay, one part of ſalt thus treated, will give two parts of cryſtals. Chemiſts have concluded from this phenomenon, that a ſalt well cryſtallized, contains more water than the ſame ſalt deprived of its form by the action of air or fire: and they have called this water, which is foreign to its eſſence as a ſalt, but neceſſary to its cryſtalline form, the *water of cryſtallization*, becauſe it is in fact one of the elements of their cryſtals; for when they are deprived of this water, they loſe both their tranſparency and their regular figure.

Different ſalts contain a greater or ſmaller quantity of thier water of cryſtallization. There are ſome which contain half their weight, as ſulphate of ſoda, carbonate of ſoda, and the triple ſulphate of alumine: others have but a ſmall portion, as nitre, muriate of ſoda, &c. This relative quantity of water of cryſtallization, has not yet been determined with accuracy in all the very cryſtallizable ſalts. It may be extricated from ſalts without any way altering their intrinſic nature; and it is itſelf perfectly pure, and ſimilar to diſtilled water.

21. As by what has hitherto been ſaid on the cryſtallization of ſalts, it is proved, that the different ſaline ſubſtances are not cryſtallized by the ſame proceſſes, and follow different laws in the formation of their cryſtals, it is clear, that we may avail ourſelves of this circumſtance to effect their ſeparation. Thus a ſalt cryſtallizable by refrigeration, may be obtained very accurately ſeparated from another ſalt, which is capable of being cryſtallized only by continued evaporation; as is done with the waters of Lorraine, which contain muriate and ſulphate of ſoda. Notwithſtanding this it frequently happens, that two ſalts, diſſolved in the ſame water, are often found more or leſs mingled together, whatever difference there may be in the manner in which they cryſtallize; and that we muſt have recourſe to ſeveral ſucceſſive ſolutions and cryſtallizations, to obtain them pure and unmixed. This obſerva-

tion is ſtill more important with regard to thoſe ſalts, which reſemble each other in their laws of cryſtallization; they being much more difficult to ſeparate from each other, particularly if they be in greater number. For inſtance, if the ſame water contained four ſalts equally cryſtallizable by evaporation and refrigeration, it would be impoſſible to ſeparate them by one or two ſucceſſive cryſtallizations, and the proceſs muſt be repeated a conſiderable number of times, to enable the ſlight ſhades of difference that exiſt between their cryſtallizabilities to act: for it muſt be remarked, that, though two or more ſalts are equally cryſtallizable by refrigeration or evaporation, there exiſts perceptible ſhades between them, which modify, as we may ſay, the general law; without which they would always cryſtallize together, and we could never obtain them thoroughly ſeparated; but this we can do, even with the ſalts that moſt reſemble each other in cryſtallizability. There are only a few, which make an exception to this general rule, becauſe they have a particular adherence or remarkable affinity for each other; ſuch are in general the ſalts formed by the ſame acid, and at the ſame time cryſtallizable by the ſame proceſs; but theſe ſingular adherences of ſalts to each other have not yet been ſufficiently obſerved, though it is a ſubject ſtrongly meriting the attention of chemiſts.

22. In fine, to conclude this abridged hiſtory of the cryſtallization of ſalts, I ſhall add, that there is another method of obtaining them in cryſtals. This is by precipitating them from their ſolutions by a ſubſtance which has a greater affinity than they have for water. Alcohol poured into a ſaline ſolution produces this effect with moſt neutral ſalts, ſuch only as are ſoluble in this liquid being to be excepted. The ſame phenomenon of the precipitation of ſaline cryſtals, takes place in the mixture of ſome ſalts of very different ſolubility, and even ſometimes on the mixture of different ſaline ſolutions. In general cryſtals are precipitated from ſolutions of alkaline ſalts by the lixivium of potaſh, or cauſtic ſoda, provided this lixivium be ſufficiently concentrated,

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SECTION III,

Of the Fuſibility of Salts, or the Action of Fire on theſe Subſtances.

23. THOUGH the title of this diviſion indicates, that it treats of fuſibility we muſt comprehend in this term all the effects, which ſalts are capable of undergoing from the action of fire, In this action there is a ſeries of phenomena different from each other, and which are frequently independent of fuſibility; beſides, the fuſion which ſaline ſubſtances experience, is often but one of the effects, that pre-

cede or accompany other alterations, produced by the accumulation of caloric in thoſe ſubſtances. On generalizing the whole of theſe alterations, of which ſalts are ſuſceptible by the action of fire, I find they may be reduced to ſix kinds, to which we may refer all ſaline ſubſtances: 1ſt, aqueous fuſion: 2d, igneous fuſion: 3d, decrepitation: 4th, ſimple volatilization: 5th, volatilization with alteration: 6th, decompoſition. Let us take a brief view of each of theſe actions, and ſee what it contains uſeful to be known with reſpect to the hiſtory of ſalts.

24. By aqueous fuſion we mean that liquefaction, which is owing to the water that enters into the cryſtallization of theſe ſalts. When this water is abundant, when it extends for inſtance from a third to half the weight of the ſalt, and the ſalt is at the ſame time very ſoluble, on heating the cryſtals of the ſalt, their water is increaſed in temperature, diſſolves them, and exhibits a very thick ſaline liquor. This fuſion is in fact nothing but a hot ſolution: accordingly, when the ſalt that undergoes it is ſuffered to cool, it returns to the ſolid and even cryſtallized ſtate. Likewiſe if we continue to heat a ſalt thus fuſed, its ſolvent, or water of cryſtallization becomes its water of ſolution, is volatilized, quits it, and the ſalt dries. This effect has been ſeen in the ſulphates of ſoda and magneſia, the triple ſulphate of alumine, &c. If the action of the fire be carried ſo far as to evaporate all the water

of cryſtallization by continuing to heat the ſalt after its aqueous fuſion, and if it be dried, we are then ſaid to calcine it. Formerly this was called burning a ſalt; and ſuch was the meaning of *burned alum.* Thus the effect of the aqueous fuſion is a true ſolution in boiling water.

25. By the term igneous fuſion we indicate that which ſalts experience independently of their water of cryſtallization, whether it occur after the aqueous fuſion, and ſucceed to it, or whether it be effected without this fuſion previouſly taking place. The firſt caſe completely aſcertains the difference that exiſts between the two fuſions. The ſecond exiſts when on keeping the ſalt in a ſtate of fuſion we perceive it does not dry, but remains conſtantly fluid It is ſuppoſed, that ſalts ſuſceptible of this igneous fuſion, without the aqueous fuſion preceding it, contain but little water of cryſtallization, or are much more tenacious of what they contain than the former. It is obvious, that not being ſuſceptible of loſing it, or of being dried, we cannot ſay of them, that they are calcinable. There are ſaline ſuſtances of this kind ſo fuſible, that they are even capable of ſerving as fluxes. The phoſphates and borates particularly belong to this claſs. Others are very difficult to fuſe; and though ſome are ſo to ſuch a degree that they were formerly believed to be infuſible, we are at preſent perſuaded that there is no ſalt endued with perfect

infuſibility, or the fuſion of which we cannot accompliſh by means of a ſufficient fire.

26. I rank decrepitation among the phenomena of which ſalts are ſuſceptible from the action of fire, becauſe there is in fact a pretty great number in which it takes place. The name it bears is derived from the noiſe made by the ſalt when expoſed to a ſudden heat, either by throwing it on burning coals, or by heating it ſtrongly and rapidly in a crucible. This noiſe is owing to the diſperſion of the ſaline molecules, and the manner of their ſtriking the air with which they are thrown: the ſplintery breaking of the ſalt is occaſioned by the rapid volatilization of the water, not ſufficient in quantity to produce fuſion, which flies off in the ſtate of vapour, and is ſuddenly made to occupy a ſpace much more conſiderable than that which is filled before between the ſaline molecule, among which it was concealed. It is evident, that a ſalt after decrepitation, or being deprived of its water of cryſtallization, is preciſely in the ſame ſtate as one that has been dried after aqueous fuſion. This phenomenon is very ſtrikingly exhibited by the ſulphates of barites, lime, ſtrontian, and pot-aſh, the nitrates of barite and ſtrontian, and the muriates of pot-aſh, ſoda, &c.

27. The ſimple volatilization of a ſalt, without its experiencing any intrinſic change, ſuppoſes an attraction between its component parts too ſtrong to be overcome by caloric; and at

the ſame time a tendency to combine with it, which enables them to aſſume the gaſeous form without ſeparating from one another. There are very few ſaline ſubſtances which poſſeſs theſe two properties; and though it might be truly ſaid, that ſcarcely any one is exempt from volatilization at a very high temperature, there are but very few capable of riſing in the ſtate of vapour, and at the ſame time preſerving the exact proportion and complete adherence of their conſtituent parts. The muriate and carbonate of ammonia are thoſe to which this ſimple volatility, accompanied with their preſervation and integrity in the moſt ſtriking degree, is commonly attributed. Yet ſeveral chemiſts have remarked, that, on ſubliming either of them, an ammoniacal ſmell exhaled, which appeared to indicate a partial decompoſition of theſe two ammoniacal ſalts.

28. It is in fact much more common for the action of fire on volatile ſaline ſubſtances, and more particularly on the ammoniacal ſalts, ſince it is among theſe we find the moſt volatile, and perhaps, the only ones that are completely ſo, not to confine itſelf to their ſimple ſublimation, or at leaſt at the moment when it effects this, it begins to diminiſh the attraction of their principles, and occaſion their diſunion. This takes place when the ammonia is united to an acid more fixed and leſs decompoſable than itſelf, and then the ſalt ſublimed is found to have an exceſs of acid, or to be truly acidulous. Thus

it is with the ammoniacal ſulphate in particular; and perhaps the muriate of ammonia itſelf is nearly to be claſſed with it, as it appears to undergo an alteration ſomewhat analogous from the action of fire.

29. Many ſalts experience a decompoſition more or leſs complete from the action of caloric accumulated in greater or ſmaller quantity. On comparing every thing that occurs in this ſpecies of action to all the ſaline ſubſtances, we know, we find four kinds of very diſtinct decompoſition, to which the effects produced on theſe matters by fire, may be referred.

a. Sometimes the acid flies off, and quits the ſaline compound, ſo as to be capable of being collected in a receiver, and to leave the baſe uncombined. For this it is requiſite, that the acid on the one hand be volatile, and not decompoſable by heat; and beſides, that its attraction for the baſe be ſufficiently weak to yield to the action of fire. Thus it is with the ſulphate, muriate, and carbonate of zircone, the muriates of magneſia, zircone, and alumine, the carbonates of lime, magneſia, glucine, zircone, and even thoſe of lime and ſoda.

b. Some ſalts are decompoſed by fire, in a mode the reverſe of the preceding. It is the baſe which is diſengaged from the acids, becauſe it is volatile, and adheres feebly to them. To this kind of decompoſition, we muſt refer what takes place with ſuch of the ammoniacal ſalts as part with their ammonia, and leave their acid bare when expoſed to a high temperature. Such, among others, are the phoſphate and the borate of ammonia. This it is obvious, goes further than partial diſengagement, and the formation of an acidule.

c. There are ſalts ſuſceptible of a more thorough alteration by the action of fire, becauſe their acid is capable of being decompoſed by it, and reduced wholly, or in part to its elements. Such are all the nitrates, ſuper-oxigenated muriates, ſulphites, and phoſphites. The firſt, more or leſs ſtrongly heated, give out, as already has been ſeen, oxigen gas and azote gas, and are thus reduced to their pure baſes. The ſecond loſe their oxigen, and again become muriates. Thoſe of the third and fourth kinds loſe the ſulphur or phoſphorus which they contain in exceſs, and thus return to the ſtate of ſulphates or phoſphates.

d. Laſtly, there are ſome which are ſtill more intimately and completely altered by the action of caloric than the preceding, both their acid and their baſe being reciprocally decompoſed at the ſame time. Theſe are, in fact, much more rare, for we know ſcarcely any one of this kind, except the ammoniacal nitrate: but there is reaſon to believe, that by ſtudying more carefully the different ſaline ſubſtances hitherto little known, ſeveral ſpecies will ſome day be found to belong to this order of igneous alteration.

SECTION IV.

Of the Action of Air on Salts.

30. ALL cryſtallized ſalts expoſed to the air are not altered in the ſame manner. There are ſome which experience no perceptible change; but ſeveral, more or leſs readily, loſe their tranſparency and figure; and of theſe, ſome gradually diſſolve with an addition of weight, others loſe a portion of their ſubſtance and become pulverulent. The firſt of theſe alterations has received the name of deliqueſcence; the ſecond, that of efflorefcence.

31. One of theſe phenomena has been called deliqueſcence, becauſe the ſaline ſubſtance that exhibits it, becomes liquid. It was alſo ſaid formerly, that a ſalt deliqueſced, or melted *per deliquium*, when it was thus diſſolved by the contact of air. The word *defaillance* (fainting) was thus ſynonimous with deliqueſcence: but this expreſſion has grown obſolete, and it is ſcarcely ever found, at preſent, in chemical books. This alteration is produced by the ſalt's attracting the humidity contained in the air, and I have thought proper to conſider it as the effect of a true elective attraction, which is ſtronger between the ſalt and the water, than between the water and the air of the atmoſphere. Deliqueſcence is not the ſame in all ſalts, either with reſpect to the rapidity of its taking place,

or the degree of ſaturation to which it is limited. There are ſome, as the nitrates and muriates of lime and magneſia, which attract the water from the air, and dry it as we may ſay, with very conſiderable energy, by abſorbing a quantity of that fluid greater than their own weight. Some others alſo are very deliqueſcent, but do not attract the humidity of the air with equal promptneſs in ſo large a quantity: and laſtly, there are others, which only acquire a perceptible moiſture, and do not completely diſſolve, as the nitrate of ſoda, muriate of potaſh, ammoniacal ſulphate, &c.

32. Efflorescence has been ſo called, becauſe the ſalts ſuſceptible of it, appear to become covered with little white filaments, ſimilar to the ſublimed ſubſtances, known in chemiſtry by the name of *flowers*. This property is the reverſe of deliqueſcence: in the latter, the ſaline cryſtals decompoſe the humid atmoſphere, becauſe they have a ſtronger elective attraction than the air of the atmoſphere has for water: in effloreſcence, on the contrary, it is the atmoſphere that decompoſes the ſaline cryſtals, becauſe the air has a greater affinity for water than the ſalts that form the cryſtals. It is their water of cryſtallization, therefore, which is taken from them by effloreſcence; and this is the reaſon why ſalts when they effloreſce loſe their tranſparency, their figure, and part of their maſs. It is eſſential to obſerve, that all effloreſcent ſaline cryſtals undergo an alteration from the action of

the air, ſimilar to what is produced in them by heat: it is a ſort of ſlow and cold calcination that decompoſes the cryſtallized ſalts, and ſeparates from them the water, to which they owed their cryſtalline forms, as well as all the properties that diſtinguiſhed them as *ſaline cryſtals.* Accordingly, a ſalt completely effloreſced, experiences preciſely the ſame loſs of weight in this proceſs, as when it is dried by the action of fire. It is to be remarked alſo, that the effloreſcent ſalts belong to the claſs of the moſt ſoluble, and of thoſe which cryſtallize by the refrigeration of their ſolutions.

33. As with deliqueſcence, ſo with effloreſcence, it is not the ſame with reſpect to all the neutral ſalts in which it is obſerved. There are ſome, as the ſulphate and carbonate of ſoda, which effloreſce ſpeedily, and to the very laſt cryſtalline particle, ſo that they are reduced to a very fine white powder. As theſe have loſt more than half their weight by this decompoſition of their cryſtals, we may thence conclude, that it is from the great quantity of water entering into their cryſtallization, they experience an effloreſcence ſo complete: and in fact, the ſalts which effloreſce but very little, as borax, alum, and ſulphate of magneſia, do not contain ſo large a quantity of this fluid in their cryſtals. If the effloreſcence depend on a ſtronger elective attraction between the air and the water, than between the water and the ſalt, this phenomenon will take place in a more ſpeedy and

ſtriking manner when the atmoſphere is very dry: and this agrees preciſely with obſervation, while air loaded with moiſture has not the ſame action on the efflореſcent ſalts, but leaves them unattacked. This aſſertion may be further confirmed by pouring a ſmall quantity of water on ſaline cryſtals ſuſceptible of efflореſcence: for this being done, the atmoſphere takes up this water, and ſaturating itſelf with it does not attract that which enters into the conſtitution of the cryſtals, and theſe remain unaltered: but if we do not take care to renew the water, the air will then act on the cryſtallized ſalt, and deſtroy its cryſtallization. This phenomenon is daily obſerved in pharmacy, and the venders of drugs take care to moiſten the cryſtals of ſulphate of ſoda with a ſmall quantity of water, in order to preſerve their beauty and integrity.

SECTION V.

Of the Solubility of Salts or their Relation to Water.

34. THE ſolution of ſalts in water, or the manner in which theſe bodies diſſolve in this liquid, the relative quantity they require to diſſolve them, and the phenomena which take place during their ſolution, deſerve the moſt ſerious attention of chemiſts, and this has been paid them;

for they are among the things that have been moſt ſtudied, and obſerved with the greateſt care and accuracy in our laboratories. As it is effected, that is to ſay, as ſalts diſſolve and become liquid without movement, without agitation, and without bubbles; while there are many bodies, which, while they ſhare the liquidity of acids, &c. excite much movement, and occaſion the extrication of many bubbles of elaſtic fluids in what is called efferveſcence; ſome chemiſts have propoſed to make a diſtinction between theſe two diſſolutions, and to call the firſt, that of ſaline ſubſtances, which is in fact, only a ſeparation of the molecules effected by water, *ſolution*, the other *diſſolution*. But the difference between theſe two expreſſions, which is little perceptible, has not been admitted by the majority of chemiſts. It is important, however, to obſerve here, that the difference between the two phenomena conſiſts in this, that a ſalt diſſolving in water does not change its nature any more than the water itſelf, but when a metal is diſſolved in an acid, the nature of both theſe ſubſtances is changed before they unite.

35. Though there is no real change of nature between the ſalts, and the water that unite in diſſolution, this effect muſt not be conſidered as a phenomenon ſimply phyſical, as a mere mechanical diviſion of parts. There is an intimate penetration of the molecules; their relations of diſtance and attraction are at onc

modified; they loſe or abſorb caloric; moſt frequently this principle is evolved, and the denſity of the ſubſtances augments, or becomes greater than the mean that ſhould reſult from the two known denſities. There is beſides a chemical attraction between the molecules of the ſalt, and the molecules of the water: ſince they can be ſeparated only by chemical means; ſince a ſtronger attraction of ſome other body for water as alcohol, &c. ſeparates them; and ſince all the modifications of adheſion, which can take place between the ſaline particles, and the particles of water, are the cauſes of many other modifications in the forms which the ſalts are capable of aſſuming; for this is frequently the ſource of the varieties of figure obſerved in ſaline cryſtals, owing to varied decrements on the edges and at the angles, and to an arrangement of their molecules manifeſtly dependent on attraction.

36. It has been ſeen in the detailed account of the ſpecies of ſalts, that each poſſeſſes a determinate degree of ſolubility; that is to ſay, each requires a different quantity of water for its liquefaction or ſolution. It has been ſeen likewiſe, that this degree of ſolubility varies according to the temperature of the water, augmenting in general with its increaſe. This proportion between the ſalt and the water has already been determined for a pretty conſiderable number of ſaline ſubſtances; but the taſk is far from being completed, and we may affirm,

that the ſolubility of one third of the ſalts fabricated in our laboratories is not yet accurately known. The nature of the inquiries for obtaining this knowledge is ſimple, and ſufficiently eaſy; yet, there are a number of ſolubilities which have been eſtimated imperfectly, or not at all. In the purſuit of this taſk, it will not be leſs important to determine the change of temperature, or diſengagement of caloric, which takes place in every ſolution, as well as the ſpecific gravity imparted to the water by different quantities of the ſame ſalt. Tables of theſe different ſtates ſhould be made out, which would be of great utility both to the chemiſt and to the manufacturer.

37. On comparing the principal degrees of ſolubility known in ſalts, it may be remarked, that ſome not diſſolving in ſeveral thouſand times their weight of water, are commonly conſidered as *inſoluble*: that others, requiring ſeveral hundred times their weight of water, are called *difficult* to diſſolve, or *ſparingly ſoluble*; that many diſſolving in twenty, thirty, or forty times their weight, are termed *moderately ſoluble*; that a pretty conſiderable number, demanding only from four to ſix times their weight of water, are *very ſoluble*; and *the moſt* ſoluble will diſſolve in an equal weight, or leſs, or even in half their weight of water. All theſe denominations, and the phenomena they repreſent, apply in general to water at the mean temperature of our

climates; that is to ſay 12,5 degrees of the centigrade thermometer.

38. For ſalts that are more ſoluble in hot water than in cold the ſame general ſeries of ſolubility, varying in proportion to the heat of the water, may be adopted. There are ſome in which the difference is ſcarcely perceptible: there are others in which it increaſes in a very rapid ratio; in which it is double, for inſtance: and laſtly, there are ſome which are incomparably more ſoluble in hot water than in cold, ſo that the proportion between the extreme of their ſolubility in hot water, and their ſolubility in cold, is as ſix to one. There can be no doubt, that experiments made with preciſion on a great number of theſe differences, which are not known, would be of real utility to the ſcience, and lead us to truths, of which we can yet form no ſuſpicion.

ARTICLE XIV.

A Table of Salts arranged according to their Affinities, and diſtinguiſhed by ſpecific Characters.

1. HOWEVER methodical I have endeavoured to render the hiſtory of ſalts, the clue that has guided me in their claſſification and arrangement may have been loſt amid the long details

of which that hiſtory conſiſts. To render this method more diſtinct and ſtriking, which I conſider as the only mode of ſtudying in future, and of retaining in memory the properties of ſaline ſubſtances, ſo numerous at preſent, and which will become ſtill more ſo, I think it neceſſary to retrace their ſyſtematical arrangement on a ſmaller ſcale, and to annex to each particular ſpecies ſome of the properties, which may ſerve to diſtinguiſh it from all others. It is an attempt at the method and deſcriptions of Linné, applied to one of the parts of chemiſtry which appears in truth moſt ſuſceptible of it, and to which it is at the ſame time moſt neceſſary.

2. It muſt be remarked, in order to form a juſt conception of the following details, that I have taken, as generic characters only, one or two of the moſt ſtriking and diſtinct properties; that this property, or theſe properties, recurring in all the ſpecies of the genus, it muſt not be forgotten, that they may become ſpecific or diſtinguiſhing characters, with regard to the ſpecies of another genus; that thoſe which find a place in the deſcription of each ſpecies, ſerve only in ſtrictneſs to diſtinguiſh the ſpecies of the genus from each other, the preliminary idea of the generic character being always underſtood; that it is on this account the ſpecies which correſpond from the identity of their baſes in the different genera, have analogous characters, taken from the properties of theſe baſes, which,

in ſuch caſes, cannot diſtinguiſh theſe ſpecies from each other, but by the help of their generic characters. It is very rare for a ſpecies to exhibit a chemical property, which belongs excluſively to itſelf.

3. On this occaſion, I ſhall obſerve, that the Linnean method of deſcription, ſo uſeful to the ſtudy of natural hiſtory, by its preciſion, clearneſs, and the ſtriking and *decided characters* it exhibits, when well executed, is of ſuch importance in its application to chemiſtry, that this ſcience muſt expect from it, a very deſirable improvement in its ſtudy. Some modern authors have already attempted this Linnean language, and its laconic ſtyle of deſcription, in anatomy: but no chemiſt has yet made a ſimilar eſſay, either in the theoretical or practical department of chemical ſcience. What I am going to offer here, may give an idea of the advantages which we may reaſonably expect from this mode of deſcribing the properties, that depend on the nature and intimate attractions of the principles of bodies,

GENUS I.

Sulphates.

Generic characters. Affording ſulphurets, when heated red-hot with charcoal; copiouſly precipitable by the ſolution of barites.

SPECIES I.

Sulphate of Barites.

Specific Characters. Very heavy, inſipid, inſoluble; frequent in the native ſtate; indecompoſable by the acids and by the ſimple alkalis; the moſt permanent of ſalts; poiſonous.

SPECIES II.

Sulphate of Pot-aſh.

Specific Characters. Bitter, ſoluble, affording nitrate of pot-aſh with nitric acid, and ſulphate of lime with the calcareous nitrate and muriate; purgative; reſembling porcelain after its fuſion.

SPECIES III.

Acid Sulphate of Pot-Aſh.

Specific Characters. Sour, very fuſible, parting with its acid on expoſure to a ſtrong fire.

SPECIES IV.

Sulphate of Soda.

Specific Characters. A cool and bitter taſte; effloreſcing in the air; not precipitable either by ammonia or lime; an attenuant purgative.

SPECIES V.

Sulphate of Strontian.

Specific Characters. Heavy, inſipid, inſoluble; frequently foſſile with ſulphate of barites; differing from the latter by the purple colour it imparts to flame before the blow-pipe, by being decompoſable by the fixed alkalis, and by not being poiſonous.

SPECIES VI.

Sulphate of Lime.

Specific Characters. Inſipid; frequent in the earth, and in waters, which it renders hard; well cryſtallized by nature; little ſoluble; precipitable by the oxalic acid and by barites; forming plaſter by calcination.

SPECIES

SPECIES VII.

Sulphate of Ammoniac.

Specific Characters. Acrid, bitter, cryſtallizable, volatile; rendered acidulous by fire; giving out ammonia with lime.

SPECIES VIII.

Sulphate of Magneſia.

Specific Characters. Very bitter, very cryſtallizable; precipitable by lime, partly ſo by ammonia, and not at all by the carbonates of pot-aſh and ammonia; purgative.

SPECIES IX.

Ammoniaco-Magneſian Sulphate.

Specific Characters. Leſs ſoluble than the two preceding ſpecies; cryſtallizing more quickly; yielding by means of the fixed alkalis, a magneſian precipitate and volatilized ammonia.

SPECIES X.

Sulphate of Glucine.

Specific Characters. Sweetiſh and ſaccharine; precipitable by barites, and by all the alkalis, an exceſs of which re-diſſolves the precipitate; the precipitate very ſoluble in carbonate of ammonia.

SPECIES XI.

Sulphate of Alumine, Saturated or Acid.

Specific Characters. Styptic to the taſte; not cryſtallizable, forming a jelly; precipitable by potaſh and ſoda, an exceſs of which re-diſſolves the earth.

SPECIES XII.

Acid Sulphate of Alumine and Pot-aſh.

Specific Characters. Styptic to the taſte; of an octahedral figure; yielding pyrophorus when calcined with vegetable matter; aſtringent.

SPECIES XIII.

Saturated triple Sulphate of Alumine.

Specific Characters. Inſoluble, inſipid, earthy, or cryſtallized in cubes; exhibiting traces of pot-aſh and ammonia like the preceding, but not yielding pyrophorus.

SPECIES XIV.

Sulphate of Zircone.

Specific Characters. Pulverulent, or in ſmall needles; friable, inſipid, decompoſable by the heat of boiling water which precipitates its baſe; inſoluble except by the aid of the ſulphuric acid.

GENUS II.

Sulphites.

Generic Characters. Yielding ſulphur, and becoming ſulphates in the fire; exhaling the ſmell of ſulphur with effloreſcence and ſparkling, burning by the contact of ſulphuric, nitric, muriatic acids, &c.; changing into ſulphates by long expoſure to the air when they are dry, and very quickly when in a ſtate of ſolution.

Species XV.

Sulphite of Barites.

Specific Characters. Pulverulent, needled or tetrahedral; very heavy; little ſapid; inſoluble, except in an exceſs of ſulphureous acid.

Species XVI.

Sulphite of Lime.

Specific Characters. Pulverulent, or in hexahedral priſms with pyramids of ſix very long faces; little ſapid; permanent a long time in the air in its dry form; little ſoluble, leſs ſo than the ſulphate of lime.

Species XVII.

Sulphite of Pot-aſh.

Specific Characters. In radiated needles or rhomboidal laminæ; of a pungent ſulphureous taſte; decrepitating in the fire; efflorefcent; its ſolution ſpeedily abſorbing oxigen gas, and forming a pellicle of ſulphate in the air; very ſoluble; decompoſing the ſoluble ſulphates.

SPECIES XVIII.

Sulphite of Soda.

Specific Characters. Priſms of four ſides, with dihedral ſummits; a cool, ſulphureous taſte; fuſion aqueous; efflorefcent or ſoluble; cryſtallizing by refrigeration; the moſt loaded with water of cryſtallization.

SPECIES XIX.

Sulphite of Strontian.

Specific Characters. Unknown.

SPECIES XX.

Sulphite of Ammonia.

Specific Characters. Priſmatic; a cool and pungent taſte; becoming acid by ſublimation;

deliqueſcent; the moſt ſpeedily changed into ſulphate by the air.

SPECIES XXI.

Sulphite of Magneſia.

Specific Characters. In the form of flattened tetrahedra; ſoftening into a mucilage in the fire; ſwelling up much in calcination, loſeing by the action of fire the whole of its ſulphureous acid, and leaving the magneſia pure.

SPECIES XXII.

Ammoniaco-magneſian Sulphite.

Specific Characters. Cryſtallizable; yielding by fire acid ſulphite of ammonia ſublimed, and ſulphureous acid, and leaving the magneſia calcined.

SPECIES XXIII.

Sulphite of Glucine.

Specific Characters. Unknown.

SPECIES XXIV.

Sulphite of Alumine.

Specific Characters. A white greaſy powder; crackling with water; little ſoluble even in an exceſs of its acid; its acid ſolution however yielding in the air a tenacious and ductile pellicle of ſulphate.

SPECIES XXV.

Sulphite of Zircone.

Specific Characters. Unknown.

6. GENUS III.

Nitrates.

Generic Characters. Yielding impure oxigen gas mingled with azote by the action of fire, which reduces them to their baſes; giving out a white vapour with concentrated ſulphuric acid; inflaming all combuſtible ſubſtances in a red heat.

SPECIES XXVI.

Nitrate of Barites.

Specific Characters. Cryſtallizable in octahedra; very ſoluble; the only ſubſtance that yields pure barites by ſtrong calcination; the only nitrate that precipitates abundantly and forms an inſoluble ſediment with ſulphuric acid; poiſonous.

SPECIES XXVII.

Nitrate of Pot-aſh.

Specific Characters. Priſmatic; of a cool taſte; unalterable in the air; very fuſible; cooling greatly with water; yielding a ſaline and cryſtallized precipitate with oxalic acid.

SPECIES XXVIII.

Nitrate of Soda.

Specific Characters. Rhomboidal; a little deliqueſcent in the air; yielding no cryſtallized precipitate with oxalic acid.

SPECIES XXIX.

Nitrate of Strentian.

Specific Characters. Cryſtallizing like the nitrate of barites; yielding its baſe very pure by calcination; reddening the flame of the blowpipe, of a wax candle, of alcohol; precipitable by fixed alkalis; not poiſonous.

SPECIES XXX.

Nitrate of Lime.

Specific Characters. Very deliqueſcent; very acid; precipitable by the ſulphuric and oxalic acids; decompoſing the ſulphates of pot-aſh, ſoda, and ammonia.

SPECIES XXXI.

Nitrate of Ammonia.

Specific Characters. Acid, bitter, brilliant, ſatin-like, deliqueſcent; inflaming alone in cloſe veſſels, and yielding water as a product with a portion of nitric acid not decompoſed.

SPECIES XXXII.

Nitrate of Magneſia.

Specific Characters. Cryſtallizing difficultly; yielding no precipitate with ſaturated carbonate of pot-aſh; ſubſiding ſpeedily in triple cryſtals from its ſolution on the addition of that of nitrate of ammonia.

SPECIES XXXIII.

Ammoniaco-magneſian Nitrate.

Specific Characters. Very cryſtallizable; precipitating its magneſia by fixed alkali, and at the ſame time giving out ammonia.

SPECIES XXXIV.

Nitrate of Glucine.

Specific Characters. Of a ſweetiſh and ſaccharine taſte, mixed with a little roughneſs; precipitable by all the baſes, except alumine and zircone; forming with ammonia a precipitate which carbonate of ammonia re-diſſolves.

SPECIES XXXV.

Nitrate of Alumine.

Specific Characters. Not cryſtallizable; of a ſtyptic taſte; in form of jelly; yielding by ammonia a precipitate which the fixed alkalis re-diſſolve.

SPECIES XXXVI.

Nitrate of Zircone.

Specific Characters. Unknown.

7. GENUS IV.

Nitrites.

Generic Characters. Obtained by heating and half decompoſing nitrates by fire; diffuſing an orange-coloured vapour of nitrous acid when acted on by ſulphuric acid, or even by nitric acid.

SPECIES

37. *Nitrite of barites.*
38. *Nitrite of pot-aſh.*
39. *Nitrite of ſoda.*
40. *Nitrite of ſtrontian.*
41. *Nitrite of lime.*
42. *Nitrite of Ammonia.*
43. *Nitrite of magneſia.*
44. *Ammoniaco-magneſian nitrite.*
45. *Nitrite of glucine.*
46. *Nitrite of alumine.*
47. *Nitrite of zircone.*

Too little known yet as ſpecies for me to attempt to give their ſpecific characters: but it is obvious, that, to determine the particular ſpecies, when once the genus is known, the ſimple action of fire, which will leave the baſe diſengaged and pure, is ſufficient for this inveſtigation.

8. GENUS V.

Muriates.

Generic Characters. Yielding, when acted on by concentrated ſulphuric acid, a white vapour of muriatic acid, which is diſengaged with crackling and effervеſcence; yielding, when acted on by nitric acid, oxigenated muriatic acid gas; the moſt volatile and leaſt decompoſable by fire of all the ſalts.

SPECIES

SPECIES XLVIII.

Muriate of Barites.

Specific Characters. Yielding large and fine bevelled cryſtalline tablets; diffuſing a thick vapour, and at the ſame time forming a heavy and copious precipitate when acted on by ſulphuric acid; extremely attenuant and poiſonous.

SPECIES XLIX.

Muriate of Pot-Aſh.

Specific Characters. Of a cubic figure; of a bitter and ſalt taſte; forming a cryſtalline precipitate with oxalic acid; purgative and febrifuge.

SPECIES L.

Muriate of Soda.

Specific Characters. Of a cubic figure; of an agreeable ſalt taſte, being the only one that affords it among the numerous tribe of ſalts; decrepitating in the fire; affording no precipitated cryſtals with oxalic acid; the natural ſeaſoning of food both to man and to ſeveral animals.

Species LI.

Muriate of Strontian.

Specific Characters. In figure ſimilar to the muriate of barites; differing from it by being precipitable by alkalis, by the purple colour it imparts to flame, and by not being poiſonous.

Species LII.

Muriate of Lime.

Specific Characters. Cryſtallizable in a maſs, with much heat; very deliqueſcent, very acrid; producing much cold with ice; precipitated abundantly by the ſulphuric and oxalic acids; decompoſing the ſulphates of pot-aſh and ſoda by neceſſary double attractions; very attenuant, very purgative.

SPECIES LIII.

Muriate of Ammonia.

Specific Characters. Volatile, ſublimable; giving out ammonia in vapour with barites, ſtrontian, lime, pot-aſh, and ſoda; producing much cold with water; tonic, attenuant, ſtimulant, febrifuge.

SPECIES LIV.

Muriate of Magneſia.

Specific Characters. Cryſtallizing difficultly; not precipitable by the ſaturated alkaline carbonates without heat; yielding with ammonia a precipitate inſoluble in the cauſtic alkalis.

SPECIES LV.

Ammoniaco-Magneſian Muriate.

Specific Characters. Very cryſtallizable; yielding at the ſame time a precipitate inſoluble by the fixed alkalies, and a very ſtrong ammoniacal vapour.

Species LVI.

Muriate of Glucine.

Specific Characters. Of a ſweet, ſaccharine, ſlightly-aſtringent taſte; affording with the alkalis a precipitate, ſoluble in carbonate of ammonia, and re-appearing when acted on by heat.

Species LVII.

Muriate of Alumine.

Specific Characters. Not cryſtallizable; gelatinous; of an auſtere taſte; decompoſable by a ſtrong fire; forming a precipitate, very ſoluble in an exceſs of fixed alkali.

Species LVIII.

Muriate of Zircone.

Specific Characters. Of a needled form; of an auſtere taſte; eaſily yielding its acid by heat; deliqueſcent; very ſoluble; precipitating with the ſulphuric and phoſphoric acids in ſulphate or phoſphate of zircone.

SPECIES LXIV.

Super-oxigenated Muriate of Lime.

Specific Characters. Sweetiſh ſtyptic; little durable.

SPECIES LXV.

Super-oxigenated Muriate of Magneſia.

Specific Characters. Unknown.

SPECIES LXVI.

Super-oxigenated Muriate of Glucine.

Specific Characters. Unknown.

SPECIES LXVII.

Super-oxigenated Muriate of Alumine.

Specific Characters. Unknown.

SPECIES LXVIII.

Super-oxigenated Muriate of Zircone.

Specific Charcters. Unknown

10. GENUS VII.

Phoſphates.

Generic Characters. Not yielding phoſphorus when heated with charcoal; fuſible into opaque or tranſparent glaſſes; phoſphoreſcent at a high temperaturate; ſoluble in nitric acid without effervеſcence; precipitable from this ſolution by lime-water.

SPECIES LXIX.

Phoſphate of Barites.

Specific Characters. Little ſoluble; pulverulent; inſipid.

SPECIES LXX.

Phoſphate of Lime.

Specific Characters. Inſoluble, inſipid; forming a ſort of porcelain with a ſtrong fire; exiſting native in the ſtony, cryſtalline, and gem form; ſoluble in phoſphoric acid; converted into the ſtate of an acidule by the other acids.

SPECIES LXXI.

Acidulous Phoſphate of Lime.

Specific Characters. Of a ſour taſte; in the form of pearly ſcales; ſoluble; not decompoſable by the acids.

SPECIES LXXII.

Phoſphate of Strontian.

Specific Characters. Inſoluble; reddening the flame of the blow-pipe; decompoſable by lime and barites.

SPECIES LXXIII.

Phoſphate of Pot-Aſh.

Specific Characters. Not cryſtallizable; deliqueſcent; affording with lime-water a precipitate ſoluble in the acids without efferveſcence.

SPECIES LXXIV.

Phoſphate of Soda.

Specific Characters. Very cryſtallizable; efloreſcent; very fuſible by the blow-pipe; affording an opaque glaſs by refrigeration; givthe ſame precipitate with lime-water as the preceding; eaſily taking an exceſs of ſoda; purgative.

SPECIES LXXV.

Phoſphate of Ammonia.

Specific Characters. Cryſtallizable; decompoſable by fire, which fuſes it into an acid and tranſparent glaſs; affording phoſphorus with charcoal.

SPECIES LXXVI.

Phoſphate of Soda and Ammonia.

Specific Characters. Exiſting in the animal fluids; very cryſtallizable; affording with lime an inſoluble precipitate, and at the ſame time an ammoniacal vapour.

SPECIES LXXVII.

Phoſphate of Magneſia.

Specific Characters. Cryſtallizable; of a ſweetiſh taſte; little ſoluble; uniting with ammonia into a ſpecies of triple ſalt, though well neutralized and ſaturated; exiſting in human urine.

SPECIES LXXVIII.

Ammoniaco-magneſian Phoſphate.

Specific Characters. Little ſoluble; little ſapid; frequently depoſited in white ſparry ſtrata in human urinary calculi; giving out an ammoniacal vapour and magneſia when in contact with cauſtic alkalis.

SPECIES LXXIX.

Phoſphate of Glucine.

Specific Characters. Sweetiſh; yielding with lime a precipitate ſoluble in carbonate of ammonia.

SPECIES LXXX.

Phoſphate of Alumine.

Specific Characters. Thick, gelatinous; yielding with all the baſes a precipitate re-diſſolvable by cauſtic alkalis.

SPECIES LXXXI.

Phoſphate of Zircone.

Specific Characters. Unknown.

SPECIES. LXXXII.

Phoſphate of Silex.

Specific Characters. Vitreous; inſipid, inſoluble, permanent, reſembling a gem; not ſoluble in acids till it has been fuſed in four times its weight of alkali.

II. GENUS VIII.

Phoſphites.

Generic Characters. Yielding a phoſphoreſcent flame when heated; giving out a little phoſphorus in a ſtrong fire, and thus returning to the ſtate of phoſphates, but in leſs quantity than before.

SPECIES LXXXIII.

Phoſphite of Lime.

Specific Characters. In powder when v
neutral, needled when acid; not decompoſ
by any baſe.

SP

SPECIES LXXXIV.

Phoſphite of Barites.

Specific Characters. An inſipid powder; very luminous with the blow-pipe; an acidule more ſoluble than that of lime; its ſolution rendered turbid by lime-water.

SPECIES LXXXV.

Phoſphite of Strontian.

Specific Characters. Unknown.

SPECIES LXXXVI.

Phoſphite of Magneſia.

Specific Characters. Inſipid; flocculent, or in very ſmall tetrahedra; efflorefcent; little ſoluble.

SPECIES LXXXVII.

Phoſphite of Pot-aſh.

Specific Characters. A rectangular four-ſided priſm, with a dihedral ſummit; of a pungent and ſalt taſte; very little luminous with the blow-pipe; little deliqueſcent; very ſoluble, moſt with heat; precipitable by the ſolutions of lime, barites, and ſtrontian.

SPECIES LXXXVIII.

Phoſphite of Soda.

Specific Characters. A four-ſided priſm with a pyramid of four faces; ſlightly effloreſcent; not more ſoluble by heat.

SPECIES LXXXIX.

Phoſphite of Ammonia.

Specific Characters. Yielding with the blow-pipe ſtrong ſparks and phoſphoric flames with a ring of white vapour; affording by diſtillation phoſphoreous hidrogen gas.

SPECIES XC.

Ammoniaco-Magneſian Phoſphate.

Specific Characters. Uniting with a feebler degree of the property of the preceding, that of affording ſulphate of magneſia with ſulphuric acid.

SPECIES XCI.

Phoſphite of Alumine.

Specific Characters. Styptic, of a gummy conſiſtence; ſwells and puffs up in the fire.

SPECIES XCII.

Phoſphite of Glucine.

Specific Characters. Unknown.

SPECIES XCIII.

Phoſphite of Zircone.

Specific Characters. Unknown.

12. GENUS IX.

Fluates.

Generic Characters. Very weak ſalts, yielding with concentrated ſulphuric acid, a vapour which corrodes glaſs, and is precipitated by water.

SPECIES XCIV.

Fluate of Lime.

Specific Characters. Inſipid, inſoluble, ſparry reſembling glaſs in its native ſtate; phoſphoreſcent; ſoluble in the nitric and muriatic acids, and forming afterwards an inſoluble precipitate with the oxalic.

SPECIES XCV.

Fluate of Barites.

Specific Characters. Very ſoluble and cryſtallizable; precipitated in cryſtals by the oxalic acid; precipitable by the ſulphuric acid, and by the alkaline carbonates.

SPECIES XCVI.

Fluate of Strontian.

Specific Characters. Unknown.

SPECIES XCVII.

Fluate of Magneſia.

Specific Characters. Precipitated in a cloud by ammonia, and not by the ſaturated alkaline carbonates.

SPECIES XCVIII.

Fluate of Pot-Aſh.

Specific Characters. In the form of jelly; very ſoluble; precipitable by lime-water; yielding a ſoluble precipitate with oxalic acid.

SPECIES XCIX.

Siliceous Fluate of Pot-Aſh.

Specific Characters. Acted on by a ſtrong fire leaves ſiliceous pot-aſh.

SPECIES C.

Fluate of Soda.

Specific Characters. Cryſtallizing in cubes; of a ſalt, acrid taſte; precipitable by lime-water, and not by oxalic acid.

SPECIES CI.

Siliceous Fluate of Soda.

Specific Characters. Leaving, on vitrification, ſiliceous ſoda.

SPECIES CII.

Fluate of Ammonia.

Specific Characters. Decompoſable by heat, and even by ſilex; giving out ammonia with all the baſes.

SPECIES CIII.

Ammoniaco-magneſian Fluate.

Specific Characters. With the fixed alkalis precipitating magneſia, and at the ſame time exhaling an ammoniacal vapour.

SPECIES CIV.

Ammoniaco-ſiliceous Fluate.

Specific Characters. Affording a precipitate of ſilex on heating its ſolution.

SPECIES CV.

Fluate of Glucine.

Specific Characters. Of a mild ſaccharine taſte; the precipitate, formed by alkalis, ſoluble in carbonate of ammonia.

SPECIES CVI.

Fluate of Alumine.

Specific Characters. Of a gelatinous form; of an auſtere taſte; yielding with ammonia a precipitate ſoluble in the cauſtic fixed alkalis.

SPECIES CVII.

Fluate of Zircone.

Specific Characters. Unknown.

SPECIES CVIII.

Fluate of Silex.

Specific Characters. The only cryſtallizable ſiliceous ſalt; partly decompoſable by water, which ſeparates the ſilex.

12. GENUS X.

Borates.

Generic Characters. All fuſible into glaſs; their concentrated ſolutions, on the addition of the ſulphuric, nitric, and muriatic acids, &c. afford lamellated, brilliant, and pearly cryſtals of boracic acid.

SPECIES CIX.

Borate of Lime.

Specific Characters, Uncryſtallizable, inſipid, inſoluble; its ſolution in acids affording a precipitate with oxalic acid.

SPECIES CX.

Borate of Barites.

Specific Characters. Soluble, and affording a copious precipitate with ſulphuric acid.

SPECIES CXI.

Borate of Strontian.

Specific Characters. Unknown.

SPECIES CXII.

Borate of Magneſia.

Specific Characters. Inſoluble; undecompoſable by the alkalis; yielding with ſulphuric acid ſulphate of magneſia.

SPECIES CXIII.

Magneſio-calcareous Borate.

Specific Characters. Emitting ſparks with the ſteel; ſcratching glaſs; very diſtinguiſhable in the native ſtate by its ſub-cubic figure, its borders, its incomplete angles, and its electrical property.

SPECIES CXIV.

Borate of Pot-Aſh.

Specific Characters. Affording a cryſtalline precipitate with oxalic acid.

Species CXV.

Borate of Soda.

Specific Characters. Yielding no precipitate with oxalic acid; abſorbing ſoda.

Species CXVI.

Super-ſaturated Borate of Soda.

Specific Characters. Alkaline, turning blue vegetable colours green; abſorbing boracic acid.

Species CXVII.

Borate of Ammonia.

Specific Characters. Yielding ammonia by the action of fire, and fuſing into an acid glaſs.

Species CXVIII.

Ammoniaco-magneſian Borate.

Specific Characters. Yielding ammonia in the fire without melting, and ſulphate of magneſia with ſulphuric acid.

SPECIES CXIX.

Borate of Glucine.

Specific Characters. Unknown.

SPECIES CXX.

Borate of Alumine.

Specific Characters. Little ſoluble; precipitable by the alkalis.

SPECIES CXXI.

Borate of Zircone.

Specific Characters. Yielding with the blowpipe a yellowiſh glaſs; little known.

SPECIES CXXII.

Borate of Silex.

Specific Characters. Vitreous; inſipid; inſoluble; unalterable in the air.

13. GENUS XI.

Carbonates.

Generic Characters. All retaining ſome ſlight alkaline properties; with all the acids they produce a briſk and rapid effervеſcence, which is not accompanied with a white vapour.

SPECIES CXXIII.

Carbonate of Barites.

Specific Characters. Undecompoſable by fire, which cannot ſeparate its carbonic acid; loſing its acid when calcined with charcoal; poiſonous.

SPECIES CXXIV.

Carbonate of Strontian.

Specific Characters. Similar to that of barites with regard to the action of fire; imparting a purple colour to flame; not poiſonous.

SPECIES CXXV.

Carbonate of Lime.

Specific Characters. Inſipid, ſoluble by carbonic acid; converted into lime by fire.

SPECIES CXXVI.

Carbonate of Pot-Aſh.

Specific Characters. Very cryſtallizable; little alterable in the air; not precipitating the magneſian ſalts without heat.

SPECIES CXXVII.

Carbonate of Soda.

Specific Characters. Efflorescent in the air; decompoſing the magneſian ſalts without heat.

SPECIES CXXVIII.

Carbonate of Magneſia.

Specific Characters. Cryſtallizing in ſix-ſided priſms; efflorescent; decompoſable by the alkalis.

SPECIES CXXIX.

Carbonate of Ammonia.

Specific Characters. Volatile, odorant, not decompoſable by heat.

SPECIES CXXX.

Ammoniaco-magneſian Carbonate.

Specific Characters. Yielding with cauſtic fixed alkalis the ammoniacal ſmell, and at the ſame time pure magneſia.

SPECIES CXXXI.

Carbonate of Glucine.

Specific Characters. In a clotted and greaſy powder; inſipid; eaſy to be calcined; inſoluble even by its own acid; ſoluble in ammonia, in proportion as this aſſumes the ſtate of a carbonate.

SPECIES CXXXII.

Carbonate of Alumine.

Specific Characters. Loſing in the air, and by ſimple deſiccation, the greater part of the carbonic acid which it received in the humid way.

SPECIES CXXXIII.

Carbonate of Zircone.

Specific Characters. Pulverulent, inſipid, inſoluble, except in the alkaline carbonates, all which diſſolve it, and ſeem to form with it triple ſalts.

SPECIES CXXXIV.

Ammoniaco-zirconian Carbonate.

Specific Characters. More ſoluble than the carbonate of zircone; its ſolution being heated evolves ammoniacal carbonate, becomes turbid, and depoſits carbonate of zircone; not precipitable by ammonia.

SPECIES CXXXV.

Ammoniaco-glucinian Carbonate.

Specific Characters. More ſoluble than the carbonate of glucine; letting fall the latter in powder, when its ſolution is heated in contact with air, and the carbonate of ammonia is diſſipated in vapour.

14. In characterizing the hundred and thirty-five very diſtinct ſpecies of ſalts, both by their reſpective diſpoſitions, and by ſpecific properties equally diſtinct and invariable, I have endeavoured to ſhow, that their arrangement and claſſification into genera and ſpecies, after the manner of botaniſts and hiſtorians, may afford the chemical ſtudent a method not leſs eaſy and preciſe, than that which has been eſtabliſhed in the ſtudy of plants and animals. Something, however, would ſtill be wanting to this picture if I confined it to the ſimple exhibition of the arrangement I have followed in the hiſtory of ſalts, and omitted to annex to it a ſketch of another courſe, and the poſſibility of treating this ſubject ſyſtematically according to a different order.

5. From all the preceding details has appeared the reaſon why I have preferred forming the genera of ſalts from their acids; but I have mentioned that it was not impoſſible to eſtabliſh

the genera on their baſes, a mode adopted by ſeveral chemiſts. I myſelf, when I began my lectures twenty years ago, recurred to the baſes for diſtinguiſhing the genera. When I here preſent a method, the reverſe of my firſt, an enunciation of the character of the genera will be ſufficient to diſplay the advantages of that which I have preferred; I ſhall find in it likewiſe the means of multiplying the characters of our true ſaline ſpecies, for it is obvious that every genus, here founded on a ſalifiable baſe, will become an exact repreſentation of the characters that exiſt in all the ſpecies of which the difference is determined by that baſe for the genera eſtabliſhed on the acids.

16. If we admit the baſe to determine the genus of a ſalt, we ſhall have ten different genera; for we cannot make one of ſilex, which affords only two or three combinations with acids, of little permanence, or very little ſaline. If we then claſs theſe ten genera, according to the principle already adopted of the affinity of their baſes for acids, proceeding from the ſtrongeſt to the weakeſt, we ſhall have,

1. The genus of ſalts, with barites for their baſe.
2. That of ſalts, with pot-aſh for their baſe.
3. Salts of ſoda.
4. Salts of ſtrontian.
5. Salts of lime, or calcareous ſalts.
6. Ammo-

6. Ammoniacal ſalts, or thoſe with ammonia for their baſe.
7. Magneſian ſalts, or thoſe with magneſia for their baſe.
8. Salts of glucine.
9. Salts of alumine.
10. Salts of zircone.

Each of theſe genera may be characterized in the following manner:

17. The ſalts, with *barites* for their baſe, are the moſt ſolid, the moſt difficult to decompoſe; their taſte, ſolubility, and figure, vary ſo much, that we cannot derive from theſe any generic character; all are more or leſs poiſonous; almoſt all are undecompoſable by fire, if we except the nitrate, nitrite, ſulphite, phoſphate, and ſuper-oxigenated muriate, the acids of which are wholly, or in part decompoſed by heat. They are all decompoſed by the carbonates of pot-aſh, ſoda, and ammonia.

18. The ſalts, with *pot-aſh* for their baſe, are all ſapid and ſoluble, and almoſt all cryſtallizable; fire melts, calcines, vitrifies, or decompoſes them, and reduces them to their baſe. They are almoſt all bitter purgatives, attenuants, and diuretics. Of the baſes, barites is the only one that decompoſes them in general; lime decompoſes a few, but rarely. Their elements are frequently ſeparated by double elective attractions; and theſe decompoſitions are obtained chiefly by the help of calcareous ſalts.

19. The ſalts, with *ſoda* for their baſe, have

many properties in common with the preceding. On forming a genus of them, we find, as in the laſt, that they all have a pungent, bitter, ſalt taſte, that they cryſtallize more or leſs eaſily, that they much the moſt generally effloreſce in the air, that they have an aqueous fuſion, deſiccation, and calcination, which precede the igneous fuſion, the mere water of cryſtallization being the cauſe of the two laſt properties. A very decided character diſtinguiſhes them from the ſalts, with pot-aſh for their baſe; like them, they are decompoſable by barites, and likewiſe by pot-aſh, which has a ſtronger affinity than ſoda for acids.

20. The ſalts of *ſtrontian* have nothing in common in their figure, taſte, or ſolubility; ſome are inſipid and inſoluble, others are very ſoluble and very acrid. They vary equally in the manner in which they are acted upon by air and fire. But, they are all decompoſable by barites, pot-aſh, and ſoda; and they are the only ſalts which are ſo by theſe three baſes indifferently.

21. The *calcareous* ſalts, not being characterizable as a genus by their figure, taſte, or ſolubility, or by the action of air or fire on them, ſince theſe properties vary according to the different acids that are combined in them with lime, are accurately to be diſtinguiſhed only as being decompoſable by barites, pot-aſh, ſoda, and ſtrontian. Theſe baſes, when diſſolved in water, and poured into ſolutions of calcareous ſalts,

conſtantly produce a precipitation of lime. They are diſtinguiſhed alſo by being all decompoſed, and precipitated as an inſoluble ſalt by oxalic acid, a ſpecies of vegetable acid which has the ſtrongeſt attraction for lime, and takes it from all other acids.

22. The *ammoniacal* ſalts have more diſtinguiſhing characters dependant on their baſe, than the greater part of the preceding ſalts. Almoſt all have an acrid, pungent, bitter taſte, a ſolubility ſufficiently decided, are volatile and ſublimable by fire; thoſe which do not thus become volatile are decompoſed, letting their baſe, their ammonia alone, eſcape wholly or in part, and thus becoming acidulous ſalts, or being reduced to their pure acid. Beſide this, their baſe, ſo diſtinguiſhable for its pungent ſmell, is diſengaged without heat by ſimple contact with barites, pot-aſh, ſoda, ſtrontian, and lime.

23. The *magneſian* ſalts, not uniform in their phyſical properties, their figure, ſpecific gravity, &c. have, in general, however, a taſte pretty commonly bitter. Barites, pot-aſh, ſoda, ſtrontian, and lime, decompoſe them completely, and precipitate their earthy baſe; ammonia decompoſes them but in part, and forms, with the remainder, triple ſalts. A magneſian ſalt may very certainly be diſtinguiſhed by this, that its ſolution, united with the ſolution of an ammoniacal ſalt containing the ſame acid, affords, almoſt inſtantly, cryſtals, pretty quickly depoſited, of a triple ammoniaco-magneſian ſalt.

24. Salts with *glucine* for their baſe, beſide being decompoſed and precipitated by all the preceding baſes, the combinations of which have been mentioned, have two other characters, ſerving to diſtinguiſh them from every other poſſible genus, becauſe, they belong ſo excluſively to theſe ſalts, as to be met with in no other. One of theſe is a ſweetiſh, and as it were, ſaccharine taſte, which has occaſioned the earthy baſe to receive the name it bears; the other conſiſts in the ſolution by carbonate of ammonia of the earth at firſt precipitated by alkalis. The glucine is ſeparated from this ſolution by heat, which expels the ammoniacal carbonate, and then permits the glucine, which this ſalt held diſſolved in the water, to precipitate in a pulverulent and earthy form.

25. The ſalts with *alumine* for their baſe, have all a more or leſs acerb or aſtringent taſte, and ſometimes even ſtrongly ſtyptic; they are very eaſily recognized, either by this, that all the alkaline and earthy baſes, zircone excepted, decompoſe them, and precipitate their baſe, or, and indeed ſtill more particularly, by the alumine, ſeparated from their ſolution in a light flocculent form, diſſolving with very great facility in the cauſtic alkalis.

26. Laſtly, the ſalts with *zircone* for their baſe, are the weakeſt and moſt decompoſable of all. Precipitable by lime, as by all the other alkaline and earthy baſes, they are very readily diſtinguiſhed from all other ſalts, and eſpecially

from thoſe of alumine, by their earth, when ſeparated, not being ſoluble in alkalis added to it. In theſe, we know alumine readily diſſolves; and glucine, which diſſolves in them alſo, is the only baſe cauſed to diſappear by carbonate of ammonia.

ARTICLE XV.

Of the Action of Salts on each other, and of their reciprocal decompoſitions.

1. AMONG the facts depending on the properties of ſaline ſubſtances, there is not one more intereſting to the obſerver, exhibiting more curious phenomena to the chemiſt, or affording more important concluſions to artiſts and manufacturers, than the reciprocal action which they exert on one another. On comparing all the data, which ſcience has yet allowed us to collect, reſpecting this mutual action, I find it divides itſelf into ſix different phenomena; and as I have not entered into all the particulars of theſe phenomena, when giving the hiſtory of the ſpecies, which would have increaſed without much advantage, the length of that hiſtory, already of ſufficient extent, it appears to me of ſome utility, at leaſt, to exhibit a general out-line of them, in a particular article, with part of the reſults to be derived

from

from them in their application to the operations of nature, and the proceſſes of art.

2. I ſhall firſt obſerve, that ſalts ſcarcely ever act on each other, unleſs one, if not both of them, be diſſolved in water, or water be added to them, when mutually in contact. In this caſe, which diſpoſes them to reciprocal action, one or other of the ſix following circumſtances is obſerved.

A. The ſolutions mix without any alteration, and in ſuch a manner, that the ſalts may be ſeparated from one another by evaporation as pure, and the ſame in quantity, as they were before.

B. Or the two ſalts unite without any reciprocal alteration, without changing their nature, and ſo as to form a triple compound, when they are two ſpecies of the ſame genus, that is to ſay, when they contain the ſame acid, or two ſpecies of a different genus, but having the ſame baſe; which is a leſs frequent occurrence.

C. Sometimes one of the ſalts, more greedy of water than the other, takes from it this ſolvent liquid, and precipitates it from its ſolution. In this caſe, ſometimes a ſolution of a ſalt, which was not diſpoſed to cryſtallize, depoſits cryſtals on the addition of another ſaline ſolution: ſometimes, on the contrary, a ſolution, inſtead of cryſtallizing as it would have done, if it had continued pure and unmixed, affords no cryſtals, and remains a liquid.

D. There are ſalts, which mutually render each other more or leſs ſoluble by their mixture in the ſame liquid, and which thus, by their ſimultaneous contact with water, change the laws of their ſolubility. Thus, frequently, water ſaturated with a ſalt, becomes capable of diſſolving a freſh portion of it, if another ſaline ſubſtance be previouſly added to it.

E. A great number of ſalts experience a partial decompoſition by contact with each other.

F. Laſtly, many are entirely or completely decompoſed, when they are made to act on one another.

3. Of theſe ſix kinds of action, of which ſome ſtriking inſtances have been adduced in the details given of the different ſpecies of ſalts, but which have yet been far from appreciated in the mutual relations of all the ſpecies, becauſe this determination requires an immenſe labour, yet ſcarcely begun, I ſhall ſelect the laſt in particular, as the moſt important object, the moſt uſeful to be known, that, on which moſt facts have hitherto been collected, in a word, that which is beſt calculated to enable us to judge of the ſtate of advancement, at which ſcience has arrived, and the degree of perfection it will ſome day reach. In a courſe of chemical lectures twenty years ago, ſcarcely a dozen examples of the mutual decompoſitions of ſalts by each other were adduced, while at preſent, we know near two thouſand, and we have reaſon to ſuſpect a ſtill greater number. No part of the

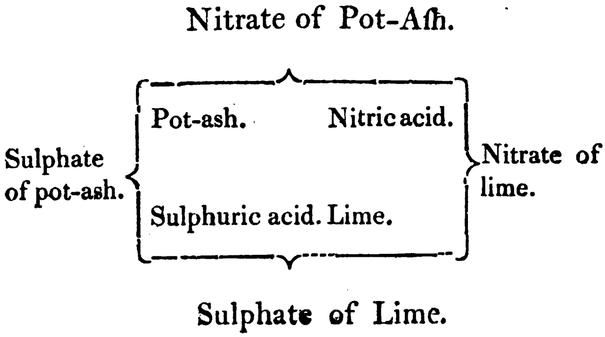
ſcience being more advantageous than this for the knowledge of a number of phenomena, both of nature and art, I ſhall exhibit it here ſufficiently at large, to ſupply what may be wanting in this reſpect in the preceding articles, dedicated to the particular hiſtory of the ſpecies. I ſhall firſt point out the general principles of theſe mutual ſaline decompoſitions: and afterward give, ſpecies by ſpecies, a view of thoſe that are either well known by experience, or eſtabliſhed on well founded preſumption.

4. Whenever two ſalts, different from each other both in their baſes and acids, undergo a mutual decompoſition, a double change of the baſes and acids takes place, and there is always a double elective attraction. This attraction, however, is to be conſidered either as *ſuperfluous*, or as *neceſſary*: it is ſuperfluous, when the baſe of that ſalt, which is employed to decompoſe the other, has more attraction for the acid of the latter ſalt than for its own; on the contrary, it is neceſſary, when, neither the acid nor the baſe of the ſalt uſed for the decompoſition of another being able to effect it, the ſimultaneous action of both is indiſpenſable for the accompliſhment of the decompoſition. Conſidered in this point of view, moſt of the double changes of acids and baſes that take place between ſalts, are effected by ſuperfluous attractions, and there are but few that require the accumulation of neceſſary attractive powers to enable them to act.

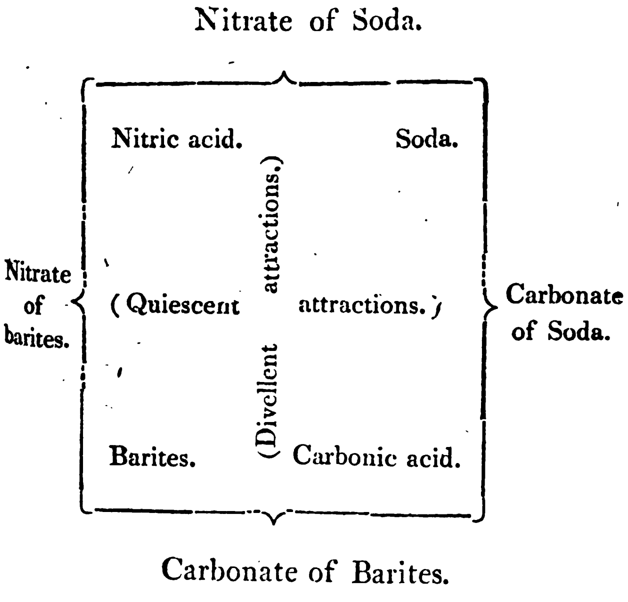
5. To judge of the actions, and particularly of the reciprocal decompoſitions which ſalts are capable of exerciſing on one another, it is uſual to mix them diſſolved in water. This fluid, keeping their reſpective molecules in a ſtate of ſeparation, enables them to act upon each other, and produce together, the effect which ought to ariſe from the attractions of their component parts. Though this effect, in the caſe of double decompoſitions, is moſt commonly announced by a precipitate, which is more or leſs quickly formed; (as the precipitation takes place only when one of the newly formed ſalts is much leſs ſoluble than the other, and than the two that exiſted before) there are caſes of decompoſition, in which the new ſalts, being very ſoluble, do not quit the water. We muſt not infer, therefore, when no precipitation takes place, that this decompoſition does not exiſt; but we ought to examine the liquor that remains clear, by ſubjecting it to ſlow evaporation, and extract from it the two ſalts that exiſt in the ſolution, ſeparating them at the ſame time from each other. Water, therefore, acts a part in theſe operations, by the kind of attraction it exerciſes either upon the ſalts mixed together previous to their reciprocal decompoſition, or on thoſe to which this reciprocal decompoſition gives birth; ſometimes it promotes or accelerates this decompoſition, and ſometimes it prevents or retards it.

6. Bergmann

6. Bergmann has given a formula, or a ſort of emblem, to repreſent the action and reſult of double decompoſitions, which may be employed with much advantage to exhibit what paſſes as the effect of double affinities between ſalts. On the two extremities of a parallelogram, formed by braces with their points outward, he writes externally the names of two ſalts brought into contact: and within theſe two vertical braces, he puts the conſtituent principles of each ſalt in ſuch a manner, that the acid of the one is oppoſite to the baſe of the other. Above the ſuperior horizontal brace, he places that new formed ſalt which remains ſuſpended or diſſolved in the water; and under the inferior brace, he puts the other new formed ſalt, which is ſeparated from it, or precipitated. For inſtance, he repreſents the double decompoſition that takes place between ſulphate of pot-aſh and nitrate of lime in the following manner:



7. Mr. Kirwan, employing the ſame repreſentation or formula, has added to it the terms of quieſcent and divellent attractions, to ſhow, that the latter overcome the former, and to expreſs the direction in which theſe attractions operate; as appears in the ſubſequent example of nitrate of barites decompoſed by carbonate of ſoda.



I have long attempted to do ſtill more for the perſpicuity and ſignificance of theſe emblems, by employing different numbers to expreſs each chemical attraction, taking care that they ſhould agree with obſervation, ſo that the form of the divellent attractions ſhould exceed that of the quieſcent. But this attempt, which is ſtill very vague and uncertain, I have been able to make only with a few of the firſt data, between a ſmall number of acids and of baſes, as may be ſeen in the volume of Memoirs of Chemiſtry, which I publiſhed in 1784. The number of theſe bodies, ſo aſtoniſhingly increaſed by the diſcoveries made ſince that period, would require, at preſent, the employment of methods much more exact, than it was in my power to adopt at that time, to appreciate the relative powers of the affinities exiſting between the acids and baſes. Simple conjectures, or numbers of convention arranged according to the general relations perceived between theſe affinities, being no longer ſufficient, I cannot now perſiſt in the execution of this plan, which would require inveſtigations much more numerous and difficult than thoſe that have hitherto been made. I ſhall content myſelf, therefore, with giving ſuch double decompoſitions of ſalts as have come to my knowledge, by arranging in one table the hundred and thirty-five ſpecies of ſalts, which I have deſcribed.

8. In this table, the number of double decompoſitions will be ſeen to amount to one thouſand ſeven hundred and ſix, without including thoſe of the nitrites, ſuper-oxigenated muriates, and phoſphites, which I have not yet been able to examine ſeparately, on account of the little knowledge yet collected, reſpecting the ſpecies of ſalts here exhibited for the firſt

time in a methodical and ſyſtematic work on chemiſtry. Of theſe 1760 decompoſitions, moſt of which are owing to ſuperfluous double attractions, there are a certain number, which, not having been thoroughly confirmed by accurate experiments, but merely inferred from the well known order of attractions, have been noted as conjectural, or ſimply probable, by placing a note of interrogation after the decompoſing ſalt.

The table which exhibits theſe double attractions and decompoſitions is conſtructed on a ſimple plan, and eaſy to be underſtood. Every ſalt is conſidered in it ſeparately, under a number correſponding to that of the rank it occupies in the ſeries of ſaline ſubſtances from I to CXXXV, the whole number of theſe compounds. The ſpecies noticed, is ſuppoſed to be placed in contact with all thoſe that follow it; ſo that the number of thoſe by which each ſpecies is treated in ſucceſſion, decreaſes as we advance.

The enumeration of the double decompoſitions of each ſpecies of ſalts, is ſeparated from that of the preceding by a ſhort line. The number and names of the ſpecies treated of in each of theſe deciſions, are printed in Roman numerals and ſmall capitals, while thoſe of the decompoſing ſpecies are in arabic figures and Italics.

For the reſt, the inſpection and ſlighteſt ſtudy of the table will give a better idea of the plan, and of the methods of abbreviation employed, than could be done by the moſt prolix introductory explanation.

A Table of the reciprocal double Decompoſitions which take Place between the hundred and thirty-five ſpecies of alkaline and earthy Salts deſcribed in this Section.

I. SULPHATE OF BARITES.

Of the 134 ſpecies of ſalts following this, there are but two, by which it is decompoſed.

1. *Carbonate of Pot-Aſh.*

The products are { ſulphate of pot-aſh.
carbonate of barites.

Neceſſary attraction.

2. *Carbonate of Soda.*

The products are { ſulphate of ſoda.
carbonate of barites.

Neceſſary attraction.

II. SULPHATE OF POT-ASH.

It is decompoſed by the fourteen following.

1. *Sulphite of Barites.*

The products are { ſulphite of pot-aſh.
ſulphate of barites.

Superfluous attraction.

2. *Nitrate of Barites.*

The products are { nitrate of pot-aſh.
ſulphate of barites.

Superfluous attraction.

3. *Nitrate of Strontian.*

The products are { nitrate of pot-aſh.
ſulphate of ſtrontian.

Neceſſary attraction.

4. *Nitrate of Lime.*

The products are { nitrate of pot-aſh.
ſulphate of lime.

Neceſſary attraction.

5, 6, 7.

The three *nitrites* of *barites*, *ſtrontian*, and *lime*. For the nitrates produced in the three preceding examples, ſubſtitute nitrites: the ſulphates precipitated, are the ſame as in thoſe examples.

8. *Muriate of Barites.*

The products are { muriate of pot-aſh,
ſulphate of barites,
Superfluous attraction.

9. *Muriate of Strontian.*

The products are { muriate of pot-aſh.
ſulphate of ſtrontian,
Neceſſary attraction.

10. *Muriate of Lime.*

The products are { muriate of pot-aſh,
ſulphate of lime.
Neceſſary Attraction.

11. *Phoſphate of Barites.*

The products are { phoſphate of pot-aſh,
ſulphate of barites.
Superfluous attraction.

12. *Phoſphite of Barites.*

The products are { phoſphite of pot-aſh.
ſulphate of barites.
Superfluous attraction.

13. *Fluate of Barites.*

The products are { fluate of pot-aſh.
fulphate of barites.
Superfluous attraction.

14. *Borate of Barites.*

The products are { borate of pot-aſh.
ſulphate of barites.
Superfluous attraction.

III. Acid Sulphate of Pot-ash.

This is decompoſed by the greater part of the ſpecies that follow it, in conſequence of the exceſs of acid it contains. Thus to the double decompoſitions of the preceding it adds the phenomenon of a number of ſimple decompoſitions effected by its exceſs of acid.

IV. Sulphate of Soda.

It is decompoſed by the twenty three following.

1. *Sulphite*

1. *Sulphite of Barites.*

The products are { ſulphite of ſoda.
ſulphate of barites

Superfluous attraction.

2. *Sulphite of Pot-Aſh.*

The products are { ſulphite of ſoda.
ſulphate of pot-aſh.

Superfluous attraction.

3. *Nitrate of Barites.*

The products are { nitrate of ſoda.
ſulphate of barites.

Superfluous attraction.

4. *Nitrate of Pot-Aſh.*

The products are { nitrate of ſoda.
ſulphate of pot-aſh.

Superfluous attraction.

5. *Nitrate of Strontian.*

The products are { nitrate of ſoda.
ſulphate of ſtrontian.

Neceſſary attraction.

6. *Nitrate of Lime.*

The products are $\begin{cases}\text{nitrate of ſoda.}\\ \text{ſulphate of lime.}\end{cases}$

Neceſſary attraction.

7, 8, 9, 10.

The Nitrites of Barites, Pot-Aſh, Strontian, and Lime, act as the nitrates: for the nitrates formed in the four preceding examples ſubſtitute nitrites; the ſulphates formed are the ſame.

11. *Muriate of Barites.*

The products are $\begin{cases}\text{muriate of ſoda.}\\ \text{ſulphate of barites.}\end{cases}$

Superfluous attraction.

12. *Muriate of Pot-Aſh.*

The products are $\begin{cases}\text{muriate of ſoda.}\\ \text{ſulphate of pot-aſh.}\end{cases}$

Superfluous attraction.

13. *Muriate of Strontian.*

The products are $\begin{cases}\text{muriate of ſoda.}\\ \text{ſulphate of ſtrontian.}\end{cases}$

Neceſſary attraction.

14. *Muriate*

14. *Muriate of Lime.*

The products are { muriate of ſoda.
ſulphate of lime.
Neceſſary attraction.

15. *Phoſphate of Barites.*

The products are { phoſphate of ſoda.
ſulphate of barites.
Superfluous attraction.

16. *Phoſphate of Pot-Aſh.*

The products are { phoſphate of ſoda.
ſulphate of pot-aſh.
Superfluous attraction.

17. *Phoſphite of Barites.*

The products are { phoſphite of ſoda.
ſulphate of barites.
Superfluous attraction.

18. *Phoſphite of Pot-Aſh.*

The products are { phoſphite of ſoda.
ſulphate of pot-aſh.
Superflous attraction.

19. *Fluate of Barites.*

The products are { fluate of ſoda.
ſulphate of barites.

Superfluous attraction.

20. *Fluate of Pot-Aſh.*

The products are { fluate of ſoda.
ſulphate of pot-aſh.

Superfluous attraction.

21. *Borate of Barites.*

The products are { borate of ſoda.
ſulphate of barites.

Superfluous attraction.

22. *Borate of Pot-Aſh.*

The products are { borate of ſoda.
ſulphate of pot-aſh.

Superfluous attraction.

23. *Carbonate of Pot-Aſh.*

The products are { carbonate of ſoda.
ſulphate of pot-aſh.

Superfluous attraction.

V. SULPHATE OF STRONTIAN.

It is decompoſed by the twenty-four following:

1. *Sulphite of Barites.*

The products are { ſulphite of ſtrontian.
ſulphate of barites.

Superfluous attraction.

2. *Sulphite of Pot-Aſh.*

The products are { ſulphate of pot-aſh.
ſulphite of ſtrontian.

Superfluous attraction.

3. *Sulphite of Soda.*

The products are { ſulphate of ſoda.
ſulphate of ſtrontian.

Superfluous attraction.

4. *Nitrate of Barites.*

The products are { nitrate of ſtrontian.
ſulphate of barites.

Superfluous attraction.

5. *Muriates*

5. *Muriate of Barites.*

The products are { muriate of ſtrontian.
{ ſulphate of barites.

Superfluous attraction.

6. *Phoſphate of Barites.*

The products are { phoſphate of ſtrontian.
{ ſulphate of barites.

Superfluous attraction.

7. *Phoſphate of Pot-Aſh.*

The products are { ſulphate of pot-aſh.
{ phoſphate of ſtrontian.

Superfluous attraction.

8. *Phoſphate of Soda.*

The products are { ſulphate of ſoda.
{ phoſphate of ſtrontian.

Superfluous attraction.

9. *Phoſphate of Ammonia.*

The products are { ſulphate of ammonia.
{ phoſphate of ſtrontian.

Neceſſary attraction.

10, 11, 12, 13.

The four *phoſphites*, with the ſame baſes as the phoſphates, decompoſe like them the ſulphate of ſtrontian. For the phoſphates ſubſtitute here phoſphites; the ſulphates formed are the ſame as in the four preceding inſtances.

14. *Fluate of Barites.*

The products are { fluate of ſtrontian.
fulphate of barites.

Superfluous attraction.

15. *Fluate of Pot-Aſh?*

The products are { ſulphate of pot-aſh.
fluate of ſtrontian.

Superfluous attraction.

16. *Fluate of Soda?*

The products are { ſulphate of ſoda.
fluate of ſtrontian.

Superfluous attraction.

17. *Fluate of Ammonia?*

The products are { ſulphate of ammonia.
fluate of ſtrontian.

Neceſſary attraction.

18. *Borate*

18. *Borate of Barites?*

The products are { borate of ſtrontian.
fulphate of barites.

Superfluous attraction.

19. *Borate of Pot-Aſh?*

The products are { ſulphate of pot-aſh.
borate of ſtrontian.

Superfluous attraction.

20. *Borate of Soda?*

The products are { ſulphate of ſoda.
borate of ſtrontian.

Superfluous attraction.

21. *Borate of Ammonia?*

The products are { ſulphate of ammonia.
borate of ſtrontian.

Superfluous attraction.

22. *Carbonate of Barites?*

The products are { carbonate of ſtrontian.
ſulphate of barites.

Superfluous attraction.

23. *Carbonate of Pot-Aſh?*

The products are { ſulphate of pot-aſh.
carbonate of ſtrontian.

Superfluous attraction.

24. *Carbonate of Soda?*

The products are { ſulphate of ſoda.
carbonate of ſtrontian.

Superfluous attraction.

VI. SULPHATE OF LIME.

IT is decompoſed by the thirty-eight following:

1. *Sulphite of Barites.*

The products are { ſulphite of lime.
ſulphate of barites.

Superfluous attraction.

2. *Sulphite of Pot-Aſh.*

The products are { ſulphate of pot-aſh.
ſulphite of lime.

Superfluous attraction.

3. *Sulphite of Soda.*

The products are { ſulphate of ſoda.
ſulphite of lime.

Superfluous attraction.

4. *Nitrate of Barites.*

The products are { nitrate of lime.
ſulphate of barites.

Superfluous attraction.

5. *Nitrate of Strontian.*

The products are { nitrate of lime.
ſulphate of ſtrontian.

Superfluous attraction.

6. *Nitrite of Barites.*

The products are { nitrite of lime.
ſulphate of barites.

Superfluous attraction.

7. *Nitrite of Strontian.*

The products are { nitrite of lime.
ſulphate of ſtrontian.

Superfluous attraction.

8. *Muriate of Barites.*

The products are } muriate of lime.
ſulphate of barites.

Superfluous attraction.

9. *Muriate of Strontian.*

The products are { muriate of lime.
ſulphate of ſtrontian.

Superfluous attraction.

10. *Phoſphate of Barites.*

The products are { phoſphate of lime.
ſulphate of barites.

Superfluous attraction.

11. *Phoſphate of Strontian.*

The products are { phoſphate of lime.
ſulphate of ſtrontian.

Superfluous attraction.

12. *Phoſphate of Pot-Aſh.*

The products are { ſulphate of pot-aſh.
phoſphate of lime.

Superfluous attraction.

13. *Phoſphate*

13. *Phoſphate of Soda.*

The products are { ſulphate of ſoda.
phoſphate of lime.

Superfluous attraction.

14. *Phoſphate of Ammonia.*

The products are { ſulphate of ammonia.
phoſphate of lime.

Neceſſary attraction.

15. *Phoſphate of Alumine.*

The products are { ſulphate of alumine.
phoſphate of lime.

Neceſſary attraction.

16, 17, 18, 19, 20, 21.

The *phoſphites* with the baſes of the ſix preceding phoſphates appear capable, like them, of decompoſing the ſulphate of lime. The products are phoſphite of lime and the ſulphates above-mentioned.

22. *Fluate of Barites?*

The products are { fluate of lime.
ſulphate of barites.

Superfluous attraction.

23. *Fluate of Strontian ?*

The products are { fluate of lime.
ſulphate of ſtrontian.

Superfluous attraction.

24. *Fluate of Magneſia ?*

The products are { ſulphate of magneſia.
fluate of lime.

Neceſſary attraction.

25. *Fluate of Pot-Aſh ?*

The products are { ſulphate of pot-aſh.
fluate of lime.

Superfluous attraction.

26. *Fluate of Soda.*

The products are { ſulphate of ſoda.
fluate of lime

Superfluous attraction.

27. *Fluate of Ammonia.*

The products are { ſulphate of ammonia.
fluate of lime.

Neceſſary attraction.

28. *Borate of Barites.*

The products are { borate of lime.
ſulphate of barites.

Superfluous attraction.

29. *Borate of Strontian.*

The products are { borate of lime.
ſulphate of ſtrontian.

Superfluous attraction.

30. *Borate of Magneſia.*

The products are { ſulphate of magneſia.
borate of lime.

Neceſſary attraction.

31. *Borate of Pot-Aſh.*

The products are { ſulphate of pot-aſh.
borate of lime.

Superfluous attraction.

32. *Borate of Soda.*

The products are { ſulphate of ſoda.
borate of lime.

Superfluous attraction.

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33 *Borate of Ammonia.*

The products are { ſulphate of ammonia.
borate of lime.

Neceſſary attraction.

34. *Carbonate of Barites?*

The products are { carbonate of lime.
ſulphate of barites.

Superfluous attraction.

35. *Carbonate of Strontian?*

The products are { carbonate of lime.
ſulphate of ſtrontian.

Superfluous attraction.

36. *Carbonate of Pot-Aſh.*

The products are { ſulphate of pot-aſh.
carbonate of lime.

Superfluous attraction.

37. *Carbonate of Soda.*

The products are { ſulphate of ſoda.
carbonate of lime.

Superfluous attraction.

38. *Carbonat*

38. *Carbonate of Ammonia.*

The products are { ſulphate of ammonia,
carbonate of lime.
Neceſſary attraction.

VII. SULPHATE OF AMMONIA.

It is decompoſed by the forty-nine following:

1. *Sulphite of Barites.*

The products are { ſulphite of ammonia.
ſulphate of barites.
Superfluous attraction.

2. *Sulphate of Pot-Aſh.*

The products are { ſulphite of ammonia.
ſulphate of pot-aſh.
Superfluous attraction.

3. *Sulphite of Soda.*

The products are { ſulphite of ammonia.
ſulphate of ſoda.
Superfluous attraction.

4. *Sulphite*

4. *Sulphite of Strontian.*

The products are { ſulphite of ammonia.
{ ſulphate of ſtrontian.

Superfluous attraction.

5. *Sulphite of Magneſia,*

The products are { ſulphite of ammonia.
{ ſulphate of magneſia,

When cold they unite into a triple ſalt.

Neceſſary Attraction.

6. *Nitrate of Barites.*

The products are { nitrate of ammonia.
{ ſulphate of barites.

Superfluous attraction.

7. *Nitrate of Pot-Aſh?*

The products are { nitrate of ammonia.
{ ſulphate of pot-aſh.

Superfluous attraction.

8. *Nitrate of Soda?*

The products are { nitrate of ammonia.
{ ſulphate of ſoda.

Superfluous attraction.

9. *Nitrate of Strontian.*

The products are { nitrate of ammonia.
ſulphate of ſtrontian.

Superfluous attraction.

10. *Nitrate of Lime.*

The products are { nitrate of ammonia.
ſulphate of lime.

Superfluous attraction.

11. *Nitrate of Magneſia.*

With heat the products are { nitrate of ammonia.
ſulphate of magneſia.
When cold the decompoſition is doubtful.
Neceſſary attraction.

12. *Ammoniaco-magneſian Nitrate.*

The products are { nitrate of ammonia.
ammoniaco-magneſian ſulphate.

Neceſſary attraction.

13, 14, 15, 16, 17, 18, 19.

The ſeven *nitrites*, with the ſame baſes as the preceding nitrates, appear to decompoſe the ſulphate of ammonia in a ſimilar manner.

20. *Muriate of Barites.*

The products are { muriate of ammonia.
ſulphate of barites.

Superfluous attraction.

21. *Muriate of Pot-Aſh.*

The products are { muriate of ammonia.
ſulphate of pot-aſh.

Superfluous attraction.

22. *Muriate of Soda.*

The products are { muriate of ammonia.
ſulphate of ſoda.

Superfluous attraction.

23. *Muriate of Strontian.*

The products are { muriate of ammonia.
ſulphate of ſtrontian.

Superfluous attraction.

24. *Muriate of Lime.*

The products are { muriate of ammonia.
ſulphate of lime.

Superfluous attraction.

25. *Muria*[illegible]*e*

25. *Muriate of Magneſia.*

The products are {
muriate of magneſia.
ammoniaco-magneſian ſulphate.

Neceſſary attraction.

26. *Ammoniaco-Magneſian Muriate.*

The products are {
muriate of ammonia.
ammoniaco-magneſian ſulphate.

Superfluous attraction.

27. *Muriate of Alumine.*

The products are {
muriate of ammonia.
ammoniaco-aluminous ſulphate, or ammoniacal alum.

Neceſſary attraction

28. *Phoſphate of Barites.*

The products are {
phoſphate of ammonia.
ſulphate of barites.

Superfluous attraction.

29. *Phoſphate*

29. *Phoſphate of Pot-Aſh.*

The products are { phoſphate of ammonia.
{ ſulphate of pot-aſh.

Superfluous attraction.

30. *Phoſphate of Soda.*

The products are { phoſphate of ammonia.
{ ſulphate of ſoda.

Superfluous attraction.

31. *Phoſphate of Soda and Ammonia.*

The products are { phoſphate of ammonia.
{ ſulphate of ſoda.

Superfluous attraction.

32, 33, 34, 35.

The four *phoſphites,* with the ſame baſes as the phoſphates decompoſe in like manner the ſulphate of ammonia: the products are the ſame ſulphates as above, and *phoſphite* inſtead of phoſphate of ammonia.

36. *Fluate of Barites.*

The products are { fluate of ammonia.
{ ſulphate of barites.

Superfluous attraction.

37. *Flua*

37. *Fluate of Strontian.*

The products are { fluate of ammonia.
ſulphate of ſtrontian.

Superfluous attraction.

38. *Fluate of Pot-Aſh.*

The products are { fluate of ammonia.
ſulphate of pot-aſh.

Superfluous attraction.

39. *Fluate of Soda.*

The products are { fluate of ammonia.
ſulphate of ſoda.

Superfluous attraction.

40. *Siliceous Fluate of Soda.*

The products are { ammoniaco-ſiliceous fluate.
ſulphate of ſoda.

Superfluous attraction.

41. *Borate of Barites.*

The products are { ammoniacal borate.
ſulphate of barites.

Superfluous attraction.

42. *Borate of Pot-Aſh.*

The products are { borate of ammonia.
{ ſulphate of pot-aſh.

Superfluous attraction.

43. *Borate of Soda.*

The products are { borate of ammonia.
{ ſulphate of ſoda.

Superfluous attraction.

44. *Carbonate of Barites.*

The products are { carbonate of ammonia.
{ ſulphate of barites.

Superfluous attraction.

45. *Carbonate of Strontian.*

The products are { carbonate of ammonia.
{ ſulphate of ſtrontian.

Superfluous attraction.

46. *Carbonate of Lime.*

The products are { carbonate of ammonia
{ ſulphate of lime.

Neceſſary attraction.

47. *Carbonate of Pot-Aſh.*

The products are { carbonate of ammonia.
ſulphate of pot-aſh.
Superfluous attraction.

48. *Carbonate of Soda.*

The products are { carbonate of ammonia.
ſulphate of ſoda.
Superfluous attraction.

49. *Carbonate of Magneſia.*

With heat the products are { carbonate of ammonia.
ſulphate of magneſia.
Neceſſary attraction.

VIII. SULPHATE OF MAGNESIA.

It is decompoſed by the forty-ſix following:

1. *Sulphite of Barites.*

The products are ſulphite of magneſia.
ſulphate of barites.
Superfluous attraction.

2. *Sulphite of Pot-Aſh.*

The products are ſulphite of magneſia.
ſulphate of pot-aſh.
Superfluous attraction.

3. *Sulphite of Soda.*

The products are ſulphite of magneſia.
ſulphate of ſoda.
Superfluous attraction.

4. *Sulphite of Strontian.*

The products are ſulphite of magneſia.
ſulphate of ſtrontian.
Superfluous attraction.

5. *Sulphite of Ammonia.*

The products are ſulphite of magneſia.
ammoniaco-magneſia ſulphate.
Neceſſary attraction.

6. *Nitrate*

6. *Nitrate of Barites.*

The products are { nitrate of magneſia.
ſulphate of barites.

Superfluous attraction.

7. *Nitrate of Pot-Aſh.*

The products are { nitrate of magneſia.
ſulphate of pot-aſh.

Superfluous attraction.

8. *Nitrate of Soda.*

The products are { nitrate of magneſia.
ſulphate of ſoda.

Superfluous attraction.

9. *Nitrate of Strontian.*

The products are { nitrate of magneſia.
ſulphate of ſtrontian.

Superfluous attraction.

10. *Nitrite of Lime.*

The products are { nitrate of magneſia.
ſulphate of lime.

Superfluous attraction.

11. *Nitrate of Ammonia.*

The products are { nitrate of magneſia.
ammoniaco-magneſian ſulphate.

Neceſſary attraction.

12, 13, 14, 15, 16, 17.

The ſix *Nitrites*, with the ſame baſes as the preceding nitrates, act like them on the ſulphate of magneſia, and decompoſe it in a ſimilar manner. In theſe decompoſitions nitrite of magneſia is conſtantly produced, with different ſulphates, according to the ſpecies of the nitrites employed.

18. *Muriate of Barites.*

The products are { muriate of magneſia.
ſulphate of barites.

Superfluous attraction.

19. *Muriate of Strontian.*

The products are { muriate of magneſia.
ſulphate of ſtrontian.

Superfluous attraction.

20. *Muriate of Lime.*

The products are { muriate of magneſia.
ſulphate of lime.

Superfluous attraction.

21. *Phoſphate of Barites.*

The products are { phoſphate of magneſia.
ſulphate of barites.

Superfluous attraction.

22. *Phoſphate of Pot-Aſh.*

The products are { phoſphate of magneſia.
ſulphate of pot-aſh.

Superfluous attraction.

23. *Phoſphate of Soda.*

The products are { phoſphate of magneſia.
ſulphate of ſoda.

Superfluous attraction.

24. *Phoſpate of Strontian ?*

The products are { phoſphate of magneſia.
ſulphate of ſtrontian.

Superfluous attraction.

25. *Phoſphate*

25. *Poſphate of Ammonia.*

The products are { phoſphate of magneſia.
ammoniaco-magneſian
ſulphate.

Superfluous attraction.

26, 27, 28, 29, 30.

The five *phoſphites* analogous to the preceding phoſphates with reſpect to their baſes decompoſe the ſulphate of magneſia in the ſame manner, and phoſphite of magneſia is formed.

31. *Fluate of Barites.*

The products are { fluate of magneſia.
ſulphate of barites.

Superfluous attraction,

32. *Fluate of Strontian.*

The products are { fluate of magneſia.
ſulphate of ſtrontian.

Superfluous attraction.

33. *Fluate of Pot-Aſh.*

The products are { fluate of magneſia.
ſulphate of pot-aſh.
Superfluous attraction.

34. *Fluate of Soda.*

The products are { fluate of magneſia.
ſulphate of ſoda.
Superfluous attraction.

35. *Fluate of Ammonia?*

The products are { fluate of magneſia.
ſulphate of ammonia.
Neceſſary attraction.

36. *Borate of Barites.*

The products are { borate of magneſia.
ſulphate of barites.
Superfluous attraction.

37. *Borate of Strontian.*

The products are { borate of magneſia.
ſulphate of ſtrontian.
Superfluous attraction.

38. *Borate of Pot-Aſh.*

The products are { magneſian borate.
ſulphate of pot-aſh.

Superfluous attraction.

39. *Borate of Soda.*

The products are { borate of magneſia.
ſulphate of ſoda.

Superfluous attraction.

40. *Borate of Ammonia.*

The products are { magneſian borate.
ammoniaco-magneſian
ſulphate.

Neceſſary attraction.

41. *Carbonate of Barites.*

The products are { carbonate of magneſia.
ſulphate of barites.

Superfluous attraction.

42. *Carbonate of Strontian.*

The products are { carbonate of magneſia.
ſulphate of ſtrontian.

Superfluous attraction.

43. *Carbonate of Lime.*

The products are { carbonate of magneſia.
ſulphate of lime.

Superfluous attraction.

44. *Carbonate of Pot-Aſh.*

The products are { ſulphate of pot-aſh.
carbonate of magneſia.

Superfluous attraction.

45. *Carbonate of Soda.*

The products are { ſulphate of ſoda.
carbonate of magneſia.

Superfluous attraction.

46. *Carbonate of Ammonia.*

The products are { ſulphate of ammonia.
carbonate of magneſia.

Neceſſary attraction.

IX.

IX. AMMONIACO-MAGNESIAN SULPHATE.

It is decompoſed by the forty-one following.

1. *Sulphite of Barites.*

The products are the triple ſulphite,
ſulphate of barites.
Superfluous attraction.

2. *Sulphite of Pot-Aſh.*

The products are the triple ſulphite.
ſulphate of pot-aſh,
Superfluous attraction.

3. *Sulphite of Soda.*

The products are the triple ſulphite
ſulphate of ſoda.
Superfluous attraction.

4. *Sulphite of Strontian.*

The products are the triple ſulphite.
ſulphate of ſtrontian,
Superfluous attraction.

5. *Nitrate*

5. *Nitrate of Barites.*

The products are { the triple nitrate
ſulphate of barites,

Superfluous attraction.

6. *Nitrate of Pot-Aſh.*

The products are { the triple nitrate,
ſulphate of pot-aſh,

Superfluous attraction.

7. *Nitrate of Soda.*

The products are { the triple nitrate,
ſulphate of ſoda,

Superfluous attraction,

8. *Nitrate of Strontian,*

The products are { the triple nitrate.
ſulphate of ſtrontian,

Superfluous attraction.

9. *Nitrate of Lime,*

The products are { the triple nitrate.
ſulphate of lime.

Superfluous attraction.

10, 11, 12, 13, 14.

The five *nitrites*, with the ſame baſes as the preceding nitrates, decompoſe, like them, the ammoniaco-magneſian ſulphate: the products are the triple nitrite and the ſame ſulphates as above.

15. *Muriate of Barites.*

The products are { the triple muriate. ſulphate of barites.

Superfluous attraction.

16. *Muriate of Pot-Aſh.*

The products are { the triple muriate. ſulphate of pot-aſh.

Superfluous attraction.

17. *Muriate of Soda.*

The products are { the triple muriate. ſulphate of ſoda.

Superfluous attraction.

18. *Muriate of Strontian.*

The products are { the triple muriate. ſulphate of ſtrontian.

Superfluous attraction.

19. *Muriate*

19. *Muriate of Lime.*

The products are { the triple muriate.
ſulphate of lime.

Superfluous attraction.

20. *Phoſphate of Barites.*

The products are { the triple phoſphate.
ſulphate of barites.

Superfluous attraction.

21. *Phoſphate of Pot-Aſh.*

The products are { the triple phoſphate.
ſulphate of pot-aſh.

Superfluous attraction.

22. *Phoſphate of Soda.*

The products are { the triple phoſphate.
ſulphate of ſoda.

Superfluous attraction.

23, 24, 25.

The three *phoſphites*, with the ſame baſes as the preceding phoſphates, decompoſe, like them, the ammoniaco-magneſian ſulphate,

26. *Fluate of Barites.*

The products are { the triple fluate.
ſulphate of barites.

Superfluous attraction.

27. *Fluate of Strontian.*

The products are { the triple fluate.
ſulphate of ſtrontian.

Superfluous attraction.

28. *Fluate of Pot-Aſh.*

The products are { the triple fluate.
ſulphate of pot-aſh.

Superfluous attraction.

29. *Fluate of Soda.*

The products are { the triple fluate.
ſulphate of ſoda.

Superfluous attraction.

30. *Fluate of Ammonia.*

The products are { fluate of magneſia.
ſulphate of ammonia.

Neceſſary attraction.

31. *Borate of Barites.*

The products are { the triple borate.
ſulphate of barites.
Superfluous attraction.

32. *Borate of Strontian.*

The products are { the triple borate.
ſulphate of ſtrontian.
Superfluous attraction.

33. *Borate of Pot-Aſh.*

The products are { the triple borate.
ſulphate of pot-aſh.
Superfluous attraction.

34. *Borate of Soda.*

The products are { the triple borate.
ſulphate of ſoda.
Superfluous attraction.

35. *Borate of Ammonia?*

The products are { ammoniacal ſulphate.
borate of magneſia.
Neceſſary Attraction.

36. *Carbonate of Barites.*

The products are
the triple carbonate.
ſulphate of barites.

Superfluous attraction.

37. *Carbonate of Strontian.*

The products are
the triple carbonate.
ſulphate of ſtrontian.

Superfluous attraction.

38. *Carbonate of Lime.*

Not cold.

With heat the products are
carbonate of ammonia.
carbonate of magneſia.
ſulphate of lime.

Neceſſary attraction.

39. *Carbonate of Pot-Aſh.*

The products are
the triple carbonate.
ſulphate of pot-aſh.

Superfluous attraction.

40 *Carbonate of Soda.*

The products are
the triple carbonate.
ſulphate of ſoda.

Superfluous attraction.

41. *Carbonate of Magneſia.*

With heat the products are { carbonate of ammonia.
{ ſulphate of magneſia.
Neceſſary attraction.

X. SULPHATE OF GLUCINE.

IT is decompoſed by the fifty-ſeven following:

1. *Sulphite of Barites.*

The products are { ſulphite of glucine.
{ ſulphate of barites.
Superfluous attraction.

2. *Sulphite of Pot-Aſh.*

The products are { ſulphite of glucine.
{ ſulphate of pot-aſh.
Superfluous attraction.

3. *Sulphite of Soda.*

The products are { ſulphite of glucine.
{ ſulphate of ſoda.
Superfluous attraction.

4. *Sulphite of Strontian.*

The products are { ſulphite of glucine.
ſulphate of ſtrontian.
Superfluous attraction.

5. *Nitrate of Barites.*

The products are { nitrate of glucine.
ſulphate of barites.
Superfluous attraction.

6. *Nitrate of Pot-Aſh.*

The products are { nitrate of glucine.
ſulphate of pot-aſh.
Superfluous attraction.

7. *Nitrate of Soda.*

The products are { nitrate of glucine.
ſulphate of ſoda.
Superfluous attraction.

8. *Nitrate of Strontian.*

The products are { nitrate of glucine.
ſulphate of ſtrontian.
Superfluous attraction.

9. *Nitrate*

9. *Nitrate of Lime.*

The products are { nitrate of glucine.
ſulphate of lime.

Superfluous attraction.

10. *Nitrate of Ammonia.*

The products are { nitrate of glucine.
ſulphate of ammonia.

Superfluous attraction.

11. *Nitrate of Magneſia.*

The products are { nitrate of glucine.
ſulphate of magneſia.

Superfluous attraction.

12. *Ammoniaco-magneſian Nitrate.*

The products are { nitrate of glucine.
ammoniaco-magneſian
ſulphate.

Superfluous attraction.

13, 14, 15, 16, 17, 18, 19, 20.

The eight *nitrites*, with the ſame baſes as the preceding nitrates, decompoſe, like them, the ſulphate of glucine. Nitrite of glucine is formed inſtead of the nitrate, and the ſame ſulphates as above.

21. *Muriate of Barites.*

The products are { muriate of glucine.
fulphate of barites.

Superfluous attraction.

22. *Muriate of Pot-Aſh.*

The products are { muriate of glucine.
ſulphate of pot-aſh.

Superfluous attraction.

23. *Muriate of Soda.*

The products are { muriate of glucine.
ſulphate of ſoda.

Superfluous attraction.

24. *Muriate of Strontian.*

The products are { muriate of glucine.
ſulphate of ſtrontian.

Superfluous attraction.

25. *Muriate of Lime.*

The products are { muriate of glucine.
ſulphate of lime.

Superfluous attraction.

26. *Muriate of Ammonia.*

The products are { muriate of glucine.
ſulphate of ammonia.

Superfluous attraction.

27. *Muriate of Magneſia.*

The products are { muriate of glucine.
ſulphate of magneſia.

Superfluous attraction.

28. *Ammoniaco-Magneſian Muriate.*

The products are { muriate of glucine
ammoniaco-magneſian
ſulphate.

Superfluous attraction.

29. *Phoſphate of Barites.*

The products are { phoſphate of glucine.
ſulphate of barites.

Superfluous attraction.

30. *Phoſphate of Strontian.*

The products are { phoſphate of glucine.
ſulphate of ſtrontian.

Superfluous attraction.

31. *Phoſphate*

31. *Phoſphate of Pot-Aſh.*

The products are { phoſphate of glucine.
ſulphate of pot-aſh.

Superfluous attraction.

32. *Phoſphate of Soda.*

The products are { phoſphate of glucine
ſulphate of pot-aſh.

Superfluous attraction.

33. *Phoſphate of Ammonia.*

The products are { phoſphate of glucine.
ſulphate of ammonia.

Superfluous attraction.

34. *Phoſphate of Magneſia.*

The products are { phoſphate of glucine.
ſulphate of magneſia.

Superfluous attraction.

35, 36, 37, 38, 39, 40.

The ſix *phoſphites*, with the ſame baſes as the phoſphates, equally decompoſe the ſulphate of glucine, forming phoſphite inſtead of phoſphate, and the ſulphates as above.

41. *Fluate*

41. *Fluate of Barites.*

The products are { fluate of glucine.
ſulphate of barites.

Superfluous attraction.

42. *Fluate of Strontian.*

The products are { fluate of glucine.
ſulphate of ſtrontian.

Superfluous attraction.

43. *Fluate of Magneſia.*

The products are { fluate of glucine.
ſulphate of magneſia.

Superfluous attraction.

44. *Fluate of Pot-Aſh.*

The products are { fluate of glucine.
ſulphate of pot-aſh.

Superfluous attraction.

45. *Fluate of Soda.*

The products are { fluate of glucine.
ſulphate of ſoda.

Superfluous attraction.

46. *Fluate of Ammonia.*

The products are { fluate of glucine,
ſulphate of ammonia.
Superfluous attraction.

47. *Borate of Barites.*

The products are { borate of glucine.
ſulphate of barites.
Superfluous attraction.

48. *Borate of Pot-Aſh.*

The products are { borate of glucine.
ſulphate of pot-aſh.
Superfluous attraction.

49. *Borate of Soda.*

The products are { borate of glucine.
ſulphate of ſoda.
Superfluous attraction.

50. *Borate of Ammonia.*

The products are { borate of glucine.
ſulphate of ammonia.
Superfluous attraction.

51. *Carbonate of Barites.*

The products are { carbonate of glucine.
ſulphate of barites.

Superfluous attraction.

52. *Carbonate of Strontian.*

The products are { carbonate of glucine.
ſulphate of ſtrontian.

Superfluous attraction.

53. *Carbonate of Lime.*

The products are { carbonate of glucine.
ſulphate of lime.

Superfluous attraction.

54. *Carbonate of Pot-Aſh.*

The products are { carbonate of glucine.
ſulphate of pot-aſh.

Superfluous attraction.

55. *Carbonate of Soda.*

The products are { ſulphate of ſoda.
carbonate of glucine.

Superfluous attraction.

56. *Carbonate of Magneſia.*

The products are { ſulphate of magneſia.
carbonate of glucine.

Superfluous attraction.

57. *Carbonate of Ammonia.*

The products are { ſulphate of ammonia.
carbonate of glucine.

Superfluous attraction.

XI. SULPHATE OF ALUMINE.

IT is decompoſed by the ſixty-four following.

1. *Sulphite of Barites.*

The products are { ſulphite of alumine.
ſulphate of barites.

Superfluous attraction.

2. *Sulphite of Pot-Aſh.*

The products are { ſulphite of alumine.
ſulphate of pot-aſh.

Superfluous attraction.

3. *Sulphite of Soda.*

The products are { ſulphite of alumine.
ſulphate of ſoda.

Superfluous attraction.

4. *Sulphite of Strontian.*

The products are { ſulphite of alumine.
ſulphate of ſtrontian.

Superfluous attraction.

5. *Sulphite of Ammonia.*

The products are { aluminous ſulphite.
ſulphate of ammonia.

Superfluous attraction.

6. *Sulphite of Magneſia.*

The products are { aluminous ſulphite.
ſulphate of magneſia.

Superfluous attraction.

7. *Ammoniáco-Magneſian Sulphite.*

The products are { aluminous ſulphite.
ammoniaco-magneſian
ſulphate.

Superfluous attraction.

8. *Sulphite of Glucine?*

The products are { aluminous ſulphite.
{ ſulphate of glucine.

Superfluous attraction.

9. *Nitrate of Barites.*

The products are { nitrate of alumine.
{ ſulphate of barites,

Superfluous attraction.

10. *Nitrate of Pot-Aſh.*

It is decompoſed in part, and ſo far as to form alum, or acid ſulphate of alumine, and of pot-aſh.

11. *Nitrate of Soda.*

The products are { nitrate of alumine.
{ ſulphate of ſoda.

Superfluous attraction.

12. *Nitrate of Strontian.*

The products are { nitrate of alumine.
{ ſulphate of ſtrontian.

Superfluous attraction.

13. *Nitrate of Lime.*

The products are { nitrate of alumine.
ſulphate of lime.

Superfluous attraction.

14. *Nitrate of Ammonia.*

The products are { nitrate of alumine.
ſulphate of ammonia.

Superfluous attraction.

15. *Nitrate of Magneſia.*

The products are { nitrate of alumine.
ſulphate of magneſia.

Superfluous attraction.

16. *Ammoniaco-Magneſian Nitrate.*

The products are { nitrate of alumine.
ammoniaco-magneſian triple ſulphate.

This decompoſition is limited.

Superfluous attraction.

17, 18, 19, 20, 21, 22, 23, 24.

The eight *nitrites* with the ſame baſes as the preceding nitrates appear to decompoſe ſulphate of alumine in a ſimilar manner.

25. *Muriate*

25. *Muriate of Barites.*

The products are { muriate of alumine.
ſulphate of barites.
Superfluous attraction.

26. *Muriate of Pot-Aſh.*

The products are { muriate of alumine.
ſulphate of pot-aſh.
Superfluous attraction.

27. *Muriate of Soda.*

The products are { muriate of alumine.
ſulphate of ſoda.
Superfluous attraction.

28. *Muriate of Strontian.*

The products are { muriate of alumine.
ſulphate of ſtrontian.
Superfluous attraction.

29. *Muriate of Lime.*

The products are { muriate of alumine.
ſulphate of lime.
Superfluous attraction.

30. *Muriate*

30. *Muriate of Ammonia.*

The products are muriate of alumine.
ſulphate of ammonia.
Superfluous attraction.

31. *Muriate of Magneſia.*

The products are muriate of alumine.
ſulphate of magneſia.
Superfluous attraction.

32. *Ammoniaco-Magneſian Muriate.*

The products are muriate of alumine.
ammoniaco-magneſian ſulphate, and ammoniacated alum.
Superfluous attraction.

33. *Muriate of Glucine.*

The products are muriate of alumine.
ſulphate of glucine.
Superfluous attraction.

34. *Phoſphate of Barites.*

The products are phoſphate of alumine.
ſulphate of barites.
Superfluous attraction.

35. *Phoſphate*

35. *Phoſphate of Pot-Aſh.*

The products are { phoſphate of alumine.
fulphate of pot-aſh.
Superfluous attraction.

36. *Phoſphate of Soda.*

The products are { phoſphate of alumine.
ſulphate of ſoda.
Superfluous attraction.

37. *Phoſphate of Ammonia.*

The products are { phoſphate of alumine.
ſulphate of ammonia.
Superfluous attraction.

38. *Phoſphate of Magneſia?*

The products are { phoſphate of alumine.
ſulphate of magneſia.
Superfluous attraction.

39. *Phoſphate of Glucine.*

The products are { phoſphate of alumine.
ſulphate of glucine.
Superfluous attraction.

40, 41, 42, 43, 44, 45.

The ſix *phoſphites*, with the ſame baſes as the preceding phoſphates, ſeem to be capable of decompoſing, like them, the ſulphate of alumine.

46. *Fluate of Barites.*

The products are { fluate of alumine.
ſulphate of barites.

Superfluous attraction.

47. *Fluate of Strontian.*

The products are { fluate of alumine.
ſulphate of ſtrontian.

Superfluous attraction.

48. *Fluate of Magneſia.*

The products are { fluate of alumine.
ſulphate of magneſia.

Superfluous attraction.

49. *Fluate of Pot-Aſh.*

The products are { fluate of alumine.
ſulphate of pot-aſh.

Superfluous attraction.

50. *Fluate of Soda.*

The products are { fluate of alumine.
ſulphate of ſoda.

Superfluous attraction.

51. *Fluate of Ammonia.*

The products are { fluate of alumine.
ſulphate of ammonia.

Superfluous attraction.

52. *Fluate of Glucine ?*

The products are { fluate of alumine.
ſulphate of glucine.

Superfluous attraction.

53. *Borate of Barites.*

The products are { borate of alumine.
ſulphate of barites.

Superfluous attraction.

54. *Borate of Pot-Aſh.*

The products are { borate of alumine.
ſulphate of pot-aſh and
alum.

Superfluous attraction.

55. Borate

55. *Borate of Soda.*

The products are { borate of alumine.
ſulphate of ſoda.

Superfluous attraction.

56. *Borate of Ammonia.*

The products are { borate of alumine.
ſulphate of ammonia and
ammoniated alum.

Superfluous attraction.

57, 58, 59, 60, 61, 62, 63, 64.

The carbonates of barites, ſtrontian, lime, pot-aſh, ſoda, magneſia, ammonia, and glucine, decompoſe the ſulphate of alumine, and form carbonate of alumine, and the ſulphates of each of thoſe baſes.

XII. AND XIII.

THE ACID AND ACIDULOUS SULPHATES OF ALUMINE.

THESE are acted upon, like the preceding ſpecies, by the other ſalts; and each of them, like it, preſents the ſixty-four double decompoſitions exhibited above.

50. *Fluate of Soda.*

The products are
fluate of alumine.
ſulphate of ſoda.

Superfluous attraction.

51. *Fluate of Ammonia.*

The products are
fluate of alumine.
ſulphate of ammonia.

Superfluous attraction.

52. *Fluate of Glucine ?*

The products are
fluate of alumine.
ſulphate of glucine.

Superfluous attraction.

53. *Borate of Barites.*

The products are
borate of alumine.
ſulphate of barites.

Superfluous attraction.

54. *Borate of Pot-Aſh.*

The products are
borate of alumine.
ſulphate of pot-aſh and alum.

Superfluous attraction.

55. *Borate of Soda.*

The products are { borate of alumine.
ſulphate of ſoda.

Superfluous attraction.

56. *Borate of Ammonia.*

The products are { borate of alumine.
ſulphate of ammonia and
ammoniated alum.

Superfluous attraction.

57, 58, 59, 60, 61, 62, 63, 64.

The carbonates of barites, ſtrontian, lime, pot-aſh, ſoda, magneſia, ammonia, and glucine, decompoſe the ſulphate of alumine, and form carbonate of alumine, and the ſulphates of each of thoſe baſes.

XII. AND XIII.

THE ACID AND ACIDULOUS SULPHATES OF ALUMINE.

THESE are acted upon, like the preceding ſpecies, by the other ſalts; and each of them, like it, preſents the ſixty-four double decompoſitions exhibited above.

50. *Fluate of Soda.*

The products are fluate of alumine.
ſulphate of ſoda.
Superfluous attraction.

51. *Fluate of Ammonia.*

The products are fluate of alumine.
ſulphate of ammonia.
Superfluous attraction.

52. *Fluate of Glucine?*

The products are fluate of alumine.
ſulphate of glucine.
Superfluous attraction.

53. *Borate of Barites.*

The products are borate of alumine.
ſulphate of barites.
Superfluous attraction.

54. *Borate of Pot-Aſh.*

The products are borate of alumine.
ſulphate of pot-aſh and
alum.
Superfluous attraction.

55. *Borate of Soda.*

The products are borate of alumine. / ſulphate of ſoda.

The products are
- borate of alumine.
- ſulphate of ſoda.

Superfluous attraction.

56. *Borate of Ammonia.*

The products are
- borate of alumine.
- ſulphate of ammonia and ammoniated alum.

Superfluous attraction.

57, 58, 59, 60, 61, 62, 63, 64.

The carbonates of barites, ſtrontian, lime, pot-aſh, ſoda, magneſia, ammonia, and glucine, decompoſe the ſulphate of alumine, and form carbonate of alumine, and the ſulphates of each of thoſe baſes.

XII. AND XIII.

THE ACID AND ACIDULOUS SULPHATES OF ALUMINE.

THESE are acted upon, like the preceding ſpecies, by the other ſalts; and each of them, like it, preſents the ſixty-four double decompoſitions exhibited above.

50. *Fluate of Soda.*

The products are { fluate of alumine.
ſulphate of ſoda.

Superfluous attraction.

51. *Fluate of Ammonia.*

The products are { fluate of alumine.
ſulphate of ammonia.

Superfluous attraction.

52. *Fluate of Glucine ?*

The products are { fluate of alumine.
ſulphate of glucine.

Superfluous attraction.

53. *Borate of Barites.*

The products are { borate of alumine.
ſulphate of barites.

Superfluous attraction.

54. *Borate of Pot-Aſh.*

The products are { borate of alumine.
ſulphate of pot-aſh and
alum.

Superfluous attraction.

55. *Borate of Soda.*

The productſ are borate of alumine.
ſulphate of ſoda.

Superfluous attraction.

56. *Borate of Ammonia.*

The productſ are borate of alumine.
ſulphate of ammonia and
ammoniated alum.

Superfluous attraction.

57, 58, 59, 60, 61, 62, 63, 64.

The carbonates of barites, ſtrontian, lime, pot-aſh, ſoda, magneſia, ammonia, and glucine, decompoſe the ſulphate of alumine, and form carbonate of alumine, and the ſulphates of each of thoſe baſes.

XII. AND XIII.

THE ACID AND ACIDULOUS SULPHATES OF ALUMINE.

THESE are acted upon, like the preceding ſpecies, by the other ſalts; and each of them, like it, preſents the ſixty-four double decompoſitions exhibited above.

50. *Fluate of Soda.*

The products are
fluate of alumine.
ſulphate of ſoda.

Superfluous attraction.

51. *Fluate of Ammonia.*

The products are
fluate of alumine.
ſulphate of ammonia.

Superfluous attraction.

52. *Fluate of Glucine ?*

The products are
fluate of alumine.
ſulphate of glucine.

Superfluous attraction.

53. *Borate of Barites.*

The products are
borate of alumine.
ſulphate of barites.

Superfluous attraction.

54. *Borate of Pot-Aſh.*

The products are
borate of alumine.
ſulphate of pot-aſh and alum.

Superfluous attraction.

55. *Borate of Soda.*

The products are { borate of alumine.
ſulphate of ſoda.

Superfluous attraction.

56. *Borate of Ammonia.*

The products are { borate of alumine.
ſulphate of ammonia and
ammoniated alum.

Superfluous attraction.

57, 58, 59, 60, 61, 62, 63, 64.

The carbonates of barites, ſtrontian, lime, pot-aſh, ſoda, magneſia, ammonia, and glucine, decompoſe the ſulphate of alumine, and form carbonate of alumine, and the ſulphates of each of thoſe baſes.

XII. AND XIII.

THE ACID AND ACIDULOUS SULPHATES OF ALUMINE.

THESE are acted upon, like the preceding ſpecies, by the other ſalts; and each of them, like it, preſents the ſixty-four double decompoſitions exhibited above.

XIV. SULPHATE OF ZIRCONE.

IT is decompoſed by the ſeventy-ſix following:

1, 2, 3, 4, 5, 6, 7, 8, 9.

The ſulphites of barites, pot-aſh, ſoda, ſtrontian ammonia, magneſia, ammoniaco-magneſian glucine, and alumine; in ſhort, all the ſulphites, except thoſe of lime and zircone, decompoſe the ſulphate of zircone.

All theſe decompoſitions are effected by ſuper— fluous double attractions, becauſe the baſes of all theſe ſulphites have a greater affinity with the ſulphuric acid than zircone has. The products conſiſt of ſulphite of zircone in every caſe, and the ſulphate with the baſe of the decompoſing ſulphite.

10, 11, 12, 13, 14, 15, 16, 17, 18, 19.

The firſt ten ſpecies of nitrates, or all, except that with zircone for its baſe, likewiſe decompoſe the ſulphate of zircone by ſuperfluous double attractions. In theſe ten decompoſitions the products are nitrate of zircone and a ſulphate, differing in its baſe according to the decompoſing nitrate.

20, 21, 22, 23, 24, 25, 26, 27, 28, 29.

It is the ſame with the ten nitrites. Nitrite of zircone is produced in theſe decompoſitions, which we infer from the known laws of elective attraction.

30, 31, 32, 33, 34, 35, 36, 37, 38, 39.

The ten ſpecies of muriates, formed by the baſes which have a greater affinity than zircone for the ſulphuric acid, as well as for the muriatic, likewiſe decompoſe the ſulphate of zircone by ſuperfluous double attractions. In all theſe caſes muriate of zircone is produced, with the ſulphates correſponding in reſpect of their baſes to the decompoſing muriates.

40, 41, 42, 43, 44, 45, 46, 47.

The eight phoſphates of barites, ſtrontian, pot-aſh, ſoda, ammonia, magneſia, glucine, and alumine, in a word, all the phoſphates, except thoſe of lime and zircone, decompoſe the zirconian ſulphate. The double attractions here are all ſuperfluous. In each caſe phoſphate of zircone is formed, with ſulphates differing according to the ſpecies of the decompoſing phoſphates.

48, 49 50, 51, 52, 53, 54, 55.

It is the ſame with the eight following phoſphites; all the phoſphites, that of lime excepted, decompoſing the ſulphate of zircone by ſuperfluous double attractions; a phoſphite of zircone being always found.

56, 57, 58, 59, 60, 61, 62.

The ſeven fluates of barites, ſtrontian, magneſia, pot-aſh, ſoda, ammonia, and glucine, decompoſe the ſulphate of zircone by ſuperfluous double attractions. That of lime is the only one by which it is not decompoſed. In all theſe decompoſitions fluate of zircone is produced.

63, 64, 65, 66, 67.

The five borates of barites, ſtrontian, pot-aſh, ſoda, and ammonia, decompoſe the ſulphate of zircone. The borates of lime and magneſia do not appear capable of acting as the preceding.

We are wholly ignorant of the action of the borates of alumine and glucine, which are yet unknown.

Borate of zircone is uniformly produced in the decompoſitions above-mentioned.

68, 69,

68, 69, 70, 71, 72, 73, 74, 75, 76.

The carbonates with baſes of barites, ſtrontian, lime, pot-aſh, ſoda, magneſia, ammonia, glucine, and alumine, decompoſe the ſulphate of zircone by ſuperfluous double attractions. In theſe nine decompoſitions carbonate of zircone is uniformly produced, with ſulphates differing according to the baſes of the carbonates employed to affect them.

XV. SULPHATE OF BARITES.

IT is decompoſed by the twenty-ſeven following, beſide the thirteen ſulphates already mentioned.

Note. The ſulphites will not be again treated with the ſulphates, becauſe, theſe having been already examined in the fourteen preceding ſpecies, they would here be only repetitions.

1. *Nitrate of Strontian.*

The products are { nitrate of barites.
ſulphite of ſtrontian.

Neceſſary attraction.

2. *Nitrite*

2. *Nitrate of Strontian?*

The products are { nitrate of barites.
{ ſulphite of ſtrontian.

Neceſſary attraction.

3. *Muriate of Strontian.*

The products are { muriate of barites.
{ ſulphite of ſtrontian.

Neceſſary attraction.

4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14.

Of the fourteen ſpecies of phoſphates which I have made known, there are eleven that decompoſe ſulphite of barites. The phoſphates of barites, lime, and ſilex, are the only exceptions. All the double attractions here are ſuperfluous, ſince the phoſphoric acid alone decompoſes all the ſulphites.

Phoſphite of barites is uniformly produced in theſe decompoſitions: the ſulphites formed vary according to the baſes of the phoſphates employed.

The acid phoſphate of lime acts only till its exceſs of acid is abſorbed.

15, 16, 17, 18, 19, 20, 21, 22, 23.

The nine ſpecies of phoſphites anſwering to the phoſphates mentioned above, except the acid calcareous ſpecies, that of ſoda and ammonia, and that of ſilex, which are not known in this genus as in the phoſphates, decompoſe the ſulphite of barites. Phoſphite of barites is formed inſtead of phoſphate. The attractions are all of the ſuperfluous kind.

24. *Fluate of Strontian?*

The products are { fluate of barites. / ſulphite of ſtrontian.

Superfluous attraction.

No borate decompoſes this ſalt.

Three carbonates only effect its decompoſition; namely,

25. *Carbonate of Pot-Aſh.*

The products are { ſulphite of pot-aſh. / carbonate of barites.

Neceſſary attraction.

26. *Carbonate*

26. *Carbonate of Soda.*

The products are { ſulphite of ſoda.
carbonate of barites.

Neceſſary attraction.

27. *Carbonate of Ammonia.*

The products are { ſulphite of ammonia.
carbonate of barites.

Neceſſary attraction.

XVI. SULPHITE OF LIME.

IT is decompoſed by the twenty-five following:

None of the ſulphates decompoſe it, as we have ſeen in the fourteen ſpecies of this genus treated on above.

No nitrate, or nitrite decompoſes it.

No muriate decompoſes it,

1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12.

Twelve phoſphates decompoſe the ſulphite of lime. There are only that with baſe of lime, the acid calcareous phoſphate, and that of ſilex, by which it is not decompoſed.

13, 14, 15, 16, 17, 18.

Six fluates, thoſe with baſes of barites, ſtrontian, magneſia, pot-aſh, ſoda, ammonia, decompoſe the ſulphite of lime, and calcareous ſulphite is formed.

19. *Borate of Strontian?*

The products are $\left\{\begin{array}{l}\text{borate of lime.}\\ \text{ſulphite of ſtrontian.}\end{array}\right.$

Superfluous attraction.

20. *Borate of Magneſia?*

The products are $\left\{\begin{array}{l}\text{ſulphite of magneſia.}\\ \text{borate of lime.}\end{array}\right.$

Neceſſary Attraction.

21, 22, 23, 24, 25.

Five carbonates, namely, thoſe of barites, ſtrontian, pot-aſh, ſoda, and ammonia, decompoſe the ſulphite of lime, and carbonate of lime is produced. The double attractions are almoſt all neceſſary. The ſulphites formed vary according to the baſes of the carbonates employed to effect the decompoſition.

XVII.

XVII. Sulphite of Pot-Ash.

IT is decompoſed by the fifty-three following, beſide the twelve ſulphates already mentioned.

1, 2, 3, 4, 5, 6, 7, 8, 9.

The nitrates of barites, ſoda, ſtrontian, lime, magneſia, ammoniaca-magneſian glucine, alumine, and zircone, decompoſe the ſulphite of pot-aſh. Nitrate of pot-aſh is uniformly produced by theſe decompoſitions, all of which are effected by a ſuperfluous attraction, ſince the nitric acid is ſtronger than the ſulphureous.

10, 11, 12, 13, 14, 15, 16, 17, 18.

The nitrites with the ſame baſes as the forgoing nitrates effect ſimilar decompoſitions.

19, 20, 21, 22, 23, 24, 25, 26, 27, 28.

Ten muriates, thoſe of barites, ſoda, ſtrontian, lime, ammonia, magneſia, ammoniaco-magneſian, and glucine, decompoſe ſulphite of potaſh. The products are muriate of pot-aſh, and different ſulphates.

29, 30, 31, 32, 33, 34, 35, 36, 37, 38, 39.

Nine phoſphates decompoſe ſulphite of lime: there are only thoſe of barites, lime, ſtrontian, and pot-aſh, which do not decompoſe it.

40, 41, 42, 43, 44, 45, 46, 47.

Eight phoſphites, ſimilar to the phoſphates with reſpect to their baſes, that of ſoda and ammonia, which is not known, excepted, decompoſe the ſulphite of pot-aſh.

48, 49, 50, 51, 52.

Five fluates, thoſe of barites, ſtrontian, magneſia, ſoda, and ammonia, decompoſe ſulphite of pot-aſh. In theſe decompoſitions fluate of pot-aſh is formed.

No borate is known to decompoſe this ſalt.

53. *Carbonate of Soda.*

The products are { carbonate of pot-aſh.
fulphite of ſoda.

Neceſſary attraction.

XVIII.

XIX. SULPHITE OF STRONTIAN.

IT is decompoſed by the thirty-three following, beſide the nine ſulphates already noticed.

1. *Nitrate of Lime.*

The products are { nitrate of ſtrontian.
ſulphite of lime.
Superfluous attraction.

2. *Nitrate of Magneſia.*

The products are { nitrate of ſtrontian.
ſulphite of magneſia.
Superfluous attraction.

3. *Nitrate of Alumine.*

The products are { nitrate of ſtrontian.
ſulphite of alumine.
Superfluous attraction.

4. *Nitrate of Zircone.*

The products are { nitrate of ſtrontian.
ſulphite of zircone.
Superfluous attraction.

5, 6, 7, 8.

The four nitrites, with the ſame baſes as the preceding nitrates, act like them. The products are nitrite of ſtrontian with the different ſulphites.

9. *Muriate of Lime?*

The products are { muriate of ſtrontian.
ſulphite of lime.
Superfluous attraction.

10. *Muriate of Alumine.*

The products are { muriate of ſtrontian.
ſulphite of alumine.
Superfluous attraction.

11. *Muriate of Zircone.*

The products are { muriate of ſtrontian.
ſulphite of zircone.

12, 13, 14, 15, 16, 17, 18, 19, 20.

Nine phoſphates, the acid phoſphate of lime, and the phoſphates of pot-aſh, ſoda, ammonia, ſoda and ammonia, ammoniaco-magneſian, and of glucine, alumine, and zircone, decompoſe the

ſulphite

XIX. SULPHITE OF STRONTIAN.

IT is decompoſed by the thirty-three following, beſide the nine ſulphates already noticed

1. *Nitrate of Lime.*

The products are { nitrate of ſtrontian.
ſulphite of lime.
Superfluous attraction.

2. *Nitrate of Magneſia.*

The products are { nitrate of ſtrontian.
ſulphite of magneſia.
Superfluous attraction.

3. *Nitrate of Alumine.*

The products are { nitrate of ſtrontian.
ſulphite of alumine.
Superfluous attraction.

4. *Nitrate of Zircone.*

The products are { nitrate of ſtrontian.
ſulphite of zircone.
Superfluous attraction.

5, 6

5, 6, 7, 8.

The four uitrites, with the ſame baſes as the preceding nitrates, act like them. The products are nitrite of ſtrontian with the different ſulphites.

9. *Muriate of Lime?*

The products are { muriate of ſtrontian.
ſulphite of lime.

Superfluous attraction.

10. *Muriate of Alumine.*

The products are { muriate of ſtrontian.
ſulphite of alumine.

Superfluous attraction.

11. *Muriate of Zircone.*

The products are { muriate of ſtrontian.
ſulphite of zircone.

12, 13, 14, 15, 16, 17, 18, 19, 20.

Nine phoſphates, the acid phoſphate of lime, and the phoſphates of pot-aſh, ſoda, ammonia, ſoda and ammonia, ammoniaco-magneſian, and of glucine, alumine, and zircone, decompoſe the ſulphite of ſtrontian. The products are phoſphate of ſtrontian and the different ſulphites. The double attractions are all ſuperfluous on account of the feebleneſs of the ſulphureous acid.

21, 22, 23, 24, 25, 26, 27, 28.

The eight phoſphites, with the ſame baſes as the preceding, except that of ſoda and ammonia, which is not known, decompoſe the ſulphite of ſtrontian in the ſame manner as the phoſphates.

We are entirely ignorant of the action of fluates on this ſalt.

No borate is known to be capable of decompoſing it.

29, 30, 31, 32, 33.

Five carbonates appear capable of effecting its decompoſition, namely, the carbonates of barites, lime, pot-aſh, ſoda, and ammonia. In all theſe caſes carbonate of ſtrontian is formed. The double attraction is neceſſary for the carbonates of lime and ammonia; ſuperfluous for thoſe of barites, pot-aſh, and ſoda.

XX. SULPHITE OF AMMONIA.

IT is decompoſed by the forty three following, beſides the five ſulphates already mentioned.

1, 2, 3, 4, 5, 6, 7, 8.

There are eight nitrates which decompoſe the ſulphite of ammonia, namely, the nitrates of barites, ſtrontian, lime, magneſia, ammoniaco-magneſian, glucine, alumine, and zircone. The products are nitrates of ammonia, and ſulphites, varying according to the baſes of the decompoſing nitrates. The attractions are all of the ſuperfluous kind.

9, 10, 11, 12, 13, 14, 15, 16.

The eight nitrites, with the ſame baſes as the preceding nitrates, act like them on the ammoniacal ſulphite.

17, 18, 19, 20, 21, 22, 23, 24.

Eight muriates; thoſe with baſes of barites, ſtrontian, lime, magneſia, ammoniaco-magneſian, glucine, alumine, and zircone, decompoſe the ſulphite of ammonia. The products of theſe ſuperfluous double attractions are muriate of ammonia, and the different ſulphites.

25, 26, 27, 28.

Only four phoſphates, the acid phoſphate of lime, and the phoſphates of glucine, alumine, and zircone, decompoſe the ſulphite of ammonia.

29, 30, 31, 32.

The four phoſphites, with the ſame baſes, equally effect the decompoſition of the ammoniacal ſulphite.

33, 34, 35.

Three fluates, namely, thoſe of barites, ſtrontian, and magneſia, appear to decompoſe the ſulphite of ammonia.

36, 37, 38, 39, 40.

Five borates, thoſe of barites, ſtrontian, magneſia, pot-aſh, and ſoda, decompoſe the ſulphite of ammonia.

41, 42, 43.

Three carbonates only, thoſe of barites, pot-aſh, and ſoda, are capable of decompoſing the the ſulphite of ammonia.

XXI. SULPHITE OF MAGNESIA.

IT is decompoſed by the forty-two following, beſide the five ſulphates already mentioned.

1, 2, 3, 4, 5.

The five nitrates of barites, lime, glucine, alumine, and zircone, decompoſe the ſulphite of magneſia by ſuperfluous attractions. The products are nitrates of magneſia, and the different ſulphates.

6, 7, 8, 9, 10.

The five nitrites, with the ſame baſes as the preceding nitrates, appear equally to decompoſe the ſulphite of magneſia.

11, 12, 12, 14.

Four muriates, thoſe of barites ? lime ? alumine, and zircone ? appear to be capable of decompoſing fulphite of magneſia.

15, 16, 17, 18, 19, 20, 21, 22.

Eight ſpecies of phoſphates, the acid phoſphate of lime, and the phoſphates of pot-aſh, ſoda, ammonia, ammoniaco-magneſian, glucine,

cine, alumine, and zircone, appear to decompoſe the ſulphite of magneſia.

23, 24, 25, 26, 27, 28, 29, 30.

It is probable, that the eight phoſphites, with the ſame baſes as the preceding phoſphates, likewiſe decompoſe this ſalt.

31. *Fluate of Barites?*

The products are { fluate of magneſia.
ſulphite of barites.
Superfluous attraction.

32. *Fluate of Strontian.*

The products are { fluate of magneſia.
ſulphite of ſtrontian.
Superfluous attraction.

33, 34, 35, 36.

Four borates, thoſe of ſtrontian, pot-aſh, ſoda, and ammonia, decompoſe the ſulphite of magneſia.

37, 38, 39, 40, 41, 42.

Six carbonates, thoſe of barites, ſtrontian, lime, pot-aſh, ſoda, and ammonia, decompoſe the ſulphite of magneſia, almoſt all by ſuperfluous attraction. The products are carbonate of magneſia, and the different ſulphites.

XXII. AMMONIACO-MAGNESIAN SULPHITE.

IT is decompoſed by the forty-eight following, beſide the five ſulphates already noticed.

1, 2, 3, 4, 5, 6, 7.

The ſeven nitrates of barites, ſtrontian, lime, magneſia, glucine, alumine, and zircone, decompoſe the ammoniaco-magneſian ſulphite. The products are triple nitrate, and the different ſulphites.

8, 9, 10, 11, 12, 13, 14.

The ſeven nitrites with the ſame baſes as the preceding nitrates, decompoſe the ammoniaco-magneſian ſulphite in a ſimilar manner. The products are a triple nitrite, and ſulphites of different baſes according to the nitrites employed.

15, 16, 17, 18, 19, 20,

Six muriates, thoſe of barites, ſtrontian, lime, glucine, alumine, and zircone, decompoſe the ammoniaco-magneſian ſulphite. The products are triple muriate, and ſulphites varying according to the nature of the muriates uſed.

21, 22, 23, 24, 25, 26, 27.

Seven phoſphates; namely, the acid phoſphate of lime, and the phoſphates which have for their baſe pot-aſh, ſoda, ammonia, glucine, alumine, or zircone, decompoſe the ammoniaco-magneſian ſulphite. The products are a triple phoſphate, and ſulphites differing according to the baſes of the phoſphates employed for the decompoſition.

28, 29, 30, 31, 32, 33, 34.

The ſeven phoſphites, with the ſame baſes as the preceding phoſphates equally decompoſe the ammoniaco-magneſian ſulphite. The reſults are a triple phoſphite, and the different ſulphites.

35, 36, 37.

Three fluates, thoſe of barites, ſtrontian, and magneſia, decompoſe the ammoniaco-magneſian ſulphite. The products are a fluate with the double baſe, and three different ſulphites.

38, 39, 40, 41, 42.

Five borates, thoſe with baſes of ſtrontian, magneſia, pot-aſh, ſoda, and ammonia, decompoſe this triple ſulphite.

43, 44, 45, 46, 47, 48.

The ſix carbonates of barites, ſtrontian, lime, pot-aſh, ſoda, and ammonia, decompoſe the ammoniaco-magneſian ſulphite. The reſults are carbonate of magneſia and ammonia, and ſulphites differing according to the baſes of the carbonates employed for the decompoſition.

XXIII. Sulphite of glucine.

IT is decompoſed by the thirty-ſeven following. Beſides the four ſulphates already mentioned.

1, 2, 3, 4.

The four nitrates of barites, lime, alumine, and zircone, decompoſe the ſulphite of glucine. They produce a nitrate with the laſt mentioned baſe, and four different ſulphites.

5, 6, 7, 8.

The four nitrites with the ſame baſes as the preceding nitrates decompoſe the ſulphite of glucine.

9, 10, 11, 12, 13.

The five muriates of barites, ſtrontian, lime, alumine, and zircone, decompoſe the ſulphite of glucine; forming a muriate with the laſt mentioned baſe, and different ſulphites.

14, 15, 16, 17, 18, 19.

Six phoſphates, the acid phoſphate of lime, and the phoſphates of pot-aſh, ſoda, ammonia, alumine, and zircone, decompoſe the ſulphite of glucine.

20, 21, 22, 23, 24, 25.

The ſix phoſphites, with the ſame baſes as the preceding phoſphates likewiſe decompoſe the ſulphite of glucine. They form a phoſphite with this baſe, inſtead of a phoſphate.

26. *Fluate of Barites.*

The products are { fluate of glucine.
{ ſulphite of barites.

Superfluous attraction.

27. *Fluate of Strontian.*

The products are { fluate of glucine.
{ ſulphite of ſtrontian.

Superfluous attraction.

28, 29, 30.

The three borates of ſtrontian, magneſia, and ammonia, decompoſe the ſulphite of glucine.

31, 32, 33, 34, 35, 36, 37.

The ſeven carbonates of barites, ſtrontian, lime, pot-aſh, ſoda, magneſia, and ammonia, decompoſe the ſulphite of glucine.

XXIV. SULPHITE OF ALUMINE.

IT is decompoſed by the twenty-four following, beſide the ſulphate of zircone already mentioned.

1. *Nitrate of Barites.*

The products are $\left\{ \begin{array}{l} \text{nitrate of alumine.} \\ \text{ſulphite of barites.} \end{array} \right.$

Superfluous attraction.

2. *Nitrate*

2. *Nitrate of Lime.*

The products are { nitrate of alumine.
{ ſulphite of lime.

Superfluous attraction.

3. *Nitrate of Zircone.*

The products are { nitrate of alumine.
{ ſulphite of zircone.

Neceſſary attraction.

4, 5, 6.

The three *nitrites*, of barites, lime, and zircone, decompoſe the ſulphite of alumine in like manner as the preceding nitrates.

7, 8, 9.

The muriates of barites, lime, and zircone, decompoſe the ſulphite of alumine. The products are muriate of alumine, and the different ſulphites.

10, 11.

There are but two phoſphates, the acid phoſphate of lime, and the phoſphate of zircone, which are capable of decompoſing the ſulphite of alumine.

12, 13.

The two phoſphites with the ſame baſes probably effect a ſimilar decompoſition of this ſalt.

We are not acquainted with any action of the fluates, on the ſulphite of alumine.

14, 15, 16.

There is reaſon to believe, that the borates of barites, ſtrontian, and magneſia, decompoſe the ſulphite of alumine.

17, 18, 19, 20, 21, 22, 23, 24.

The eight carbonates of barites, ſtrontian, lime, pot-aſh, ſoda, magneſia, ammonia, and glucine, decompoſe the ſulphite of alumine. The products are carbonate of alumine, and the reſpective ſulphites.

XXV. SULPHITE OF ZIRCONE.

IT is decompoſed by the 15 following.

1, 2. *Nitrates of Barites, and of Lime.*

The products are
nitrate of zircone.
ſulphite of barites, or of lime.

Superfluous attraction.

3, 4. *Nitrites of Barites, and of Lime.*

The products are
nitrite of zircone.
ſulphite of barites, or of lime.

Superfluous attraction.

5, 6, 7.

Muriates of barites, ſtrontian, and lime.
Superfluous attraction.

The products are muriate of zircone, and ſulphites of barites, ſtrontian, or lime.

We are unacquainted with the action of the phoſphates, on the ſulphite of zircone, as well as with that of the phoſphites.

We are equally ignorant of the double decompoſitions effected on the ſulphite of zircone by the fluates and the borates.

8, 9, 10, 11, 12, 13, 14, 15.

The eight carbonates of barites, ſtrontian, lime, pot-aſh, ſoda, magneſia, ammonia, and glucine, decompoſe the ſulphite of zircone. The products are carbonate of zircone, and ſulphites, varying according to the nature of the decompoſing carbonates.

XXVI. NITRATE OF BARITES.

Note. The action of the nitrates on the nitrites is abſolutely unknown.

Action of the muriates: equally unknown.

We are ignorant of the action of the ſuperoxigenated muriates on this ſalt, which is decompoſed by the twelve following. Beſides the twenty ſulphates or ſulphites already noticed.

1, 2, 3.

Phoſphates of pot-aſh, ſoda, and ammonia. *Neceſſary attraction*. The products are phoſphate of barites, and different nitrates.

The phoſphites appear to have nearly the ſame action as the phoſphates.

4, 5, 6.

Among the fluates there are only thoſe of pot-aſh, ſoda, and ammonia, which appear to occaſion any change in it: but their decompoſing it is yet doubtful.

7, 8, 9.

Borates of pot-aſh, ſoda, and ammonia. *Neceſſary attraction.* The products are borate of barites, and nitrate with the different baſes.

10, 11, 12.

The carbonates of pot-aſh, ſoda, and ammonia decompoſe it by *neceſſary attraction*, and produce carbonate of barites, and nitrates of pot-aſh, ſoda, and ammonia.

XXVII. NITRATE OF POT-ASH.

IT is decompoſed by the following ſpecies. Beſide the nine ſulphates or ſulphites already noticed.

1. *Muriate*

1. *Muriate of Barites.*

The products are { muriate of pot-aſh.
nitrate of barites.

Superfluous attraction.

Action of the oxigenated muriates, unknown.

That of the phoſphates, phoſphites, fluates, borates, and carbonates, null, or little known.

XXVIII. NITRATE OF SODA.

IT is decompoſed by the ſix following. Beſide the nine ſulphates or ſulphites noticed above.

1, 2. *Muriates of Barites, and of Pot-Aſh.*

The products are { muriate of Soda.
nitrate of barites, or of pot-aſh.

Superfluous attraction.

We are unacquainted with the action of the ſuper-oxigenated muriates, on the nitrate of ſoda.

3. The phoſphate of pot-aſh decompoſes it.

The products are { phoſphate of ſoda.
nitrate of pot-aſh.

Superfluous attraction.

The action of the phoſphites is nearly the ſame as that of the phoſphates.

4. *Fluate of Pot-Aſh.*

The products are { fluate of ſoda.
nitrate of pot-aſh.

Superfluous attraction.

5. *Borate of Pot-Aſh.*

The products are { borate of ſoda.
nitrate of pot-aſh.

Superfluous attraction.

6. *Carbonate of Pot-Aſh.*

The ſame action.

The products are { carbonate of ſoda.
nitrate of pot-aſh.

Superfluous attraction.

XXIX. NITRATE OF STRONTIAN.

IT is decompoſed by the ſeventeen following, beſide the fourteen ſulphates or ſulphites already mentioned.

1, 2, 3.

Muriates of barites, pot-aſh, and ſoda.
Superfluous attraction.

The products are, muriate of ſtrontian, and nitrates of barites, pot-aſh, and ſoda.

The action of the oxigenated muriates unknown.

4, 5, 6, 7.

The phoſphates of barites, pot-aſh, ſoda, and ammonia, decompoſe it, forming phoſphate of ſtrontian, and the different nitrates.

(4, 5, 6, by *ſuperfluous attraction*; 7, by *neceſſary attraction.*)

8.

The phoſphate of ſoda and ammonia appears capable of decompoſing the nitrate of ſtrontian, as either of the two ſalts that compoſe it would?

The action of the phoſphites ſimilar to that of the phoſphates.

9. *Fluate*

9. *Fluate of Pot-Aſh.*

THIS decompoſition is probable.

10, 11.

The fluates of ſoda, and of ammonia, decompoſe the nitrate of ſtrontian, forming fluate of ſtrontian, and nitrates of ſoda and ammonia.

12, 13, 14.

The borates of pot-aſh, ſoda, and ammonia, decompoſe it as above; 12 and 13 by *ſuperfluous*, 14 by *neceſſary attraction*. The products are borate of ſtrontian, and nitrates, with the different baſes.

15, 16, 17.

Carbonates of barites, pot-aſh, and ſoda. *Superfluous attraction.*

The products are carbonate of ſtrontian, and nitrate of barites, pot-aſh, or ſoda, according to the decompoſing carbonate employed.

XXX. NITRATE OF LIME.

It is decompoſed by the twenty-five following, beſide the eight ſulphates and nine ſulphites mentioned above.

1, 2, 3, 4.

The muriates of barites, pot-aſh, ſoda, and ſtrontian, decompoſe it by ſuperfluous attraction, producing muriate of lime and different nitrates.

The action of the oxigenated muriates is unknown.

5, 6, 7, 8, 9,

The phoſphates of barites, ſtrontian, pot-aſh, ſoda, and ammonia, equally decompoſe it, the laſt by *neceſſary attraction*, all the reſt by *ſuperfluous*, producing phoſphate of lime and the different nitrates.

10.

The phoſphate of magneſia appears to be capable of decompoſing nitrate of lime, and

The products muſt be $\left\{\begin{array}{l}\text{phoſphate of lime.}\\ \text{muriate of magneſia.}\end{array}\right.$

The phoſphites have the ſame action as the phoſphates on the nitrate of lime.

11. The

11.

The fluate of barites appears to decompoſe it.

12.

The fluate of ſtrontian decompoſes nitrate of lime.

The products are { fluate of lime.
nitrate of ſtrontian.

Superfluous attraction.

13.

Fluate of magneſia: this decompoſition doubtful, as well as that of fluate of barites?

14, 15, 16.

The fluates of pot-aſh, ſoda, and ammonia, decompoſe it.

The products are { fluate of lime,
nitrate of pot-aſh, of ſoda,
or of ammonia,

17, 18, 19, 20, 21.

The borates of barites, ſtrontian, pot-aſh, ſoda, and ammonia, decompoſe it, affording as the reſults borate of lime, and nitrate of barites, ſtrontian, pot-aſh, ſoda, or ammonia.

22, 23, 24, 25.

The carbonates of barites, ſtrontian, pot-aſh, and ſoda, decompoſe the nitrate of lime, and the products are carbonate of lime, and nitrates, with the different baſes.

XXXI. NITRATE OF AMMONIA.

It is decompoſed by the fourteen following, beſide the four ſulphates or ſulphites already mentioned.

1, 2, 3, 4, 5.

The muriates of barites, pot-aſh, ſoda, ſtrontian, and lime, decompoſe the nitrate of ammonia by *ſuperfluous attraction.* The products are muriate of ammonia, and nitrates, differing according to the muriate employed.

The action of the ſuper-oxigenated muriates is unknown.

6, 7.

The phoſphate of pot-aſh and of ſoda.

The products are { phoſphate of ammonia,
nitrate of pot-aſh, or of ſoda.

Superfluous attraction.

The action of the phoſphites is nearly ſimilar to that of the phoſphates.

8, 9.

The fluates of pot-aſh and ſoda decompoſe it.

The products are
fluate of ammonia.
nitrate of pot-aſh, or of ſoda.

Superfluous attraction.

10, 11, 12.

The borates of pot-aſh and ſoda, and the ſuper-ſaturated borate of ſoda, decompoſe it.

The products are
borate of ammonia.
nitrate of pot-aſh, or of ſoda.

13, 14.

The carbonates of pot-aſh and ſoda decompoſe the nitrate of ammonia by *ſuperfluous attraction.*

The products are
carbonate of ammonia.
nitrate of pot-aſh, or of ſoda.

XXXIII. NITRATE OF MAGNESIA.

IT is decompoſed by the twenty-one following, beſide the nine ſulphates or ſulphites previouſly mentioned,

1, 2, 3, 4, 5.

The muriates of barites, pot-aſh, ſoda, ſtrontian, and lime, decompoſe the nitrate of magneſia by *ſuperfluous attraction.* The products of this decompoſition are muriate of magneſia, and the nitrates with the different baſes.

6. *Muriate of Ammonia.*

IN the action of this ſalt on the nitrate of magneſia there is a reciprocal diviſion of baſes, and we obtain two triple ſalts,

called { muriate of ammonia and magneſia.
nitrate of ammonia and magneſia.

The action of the oxigenated muriates is unknown.

7.

The phoſphate of barites ſeems to decompoſe the nitrate of magneſia?

8.

It is the ſame with the action of phoſphate of ſtrontian?

9, 10, 11.

The phoſphates of pot-aſh, ſoda, and ammonia, decompoſe the nitrate of magneſia by *ſuperfluous attraction.* The products are phoſphate of magneſia, and the reſpective nitrates; with this difference, that the phoſphate of ammonia muſt act here as in No. 6, and form two triple ſalts, or *triſules.*

The phoſphites act perceptibly as the phoſphates on the nitrate of magneſia.

12.

The fluate of barites decompoſes it by *ſuperfluous attraction.* The reſults are nitrate of barites and fluate of magneſia.

13.

The decompoſition of this ſalt by fluate of ſtrontian is only taken for granted?

14, 15, 16.

The fluates of pot-aſh, ſoda, and ammonia, decompoſe the nitrate of magneſia by *ſuperfluous attraction,* forming fluate of magneſia, and the reſpective nitrates.

7.

The borate of ſtrontian apparently ought to decompoſe it?

18, 19.

The borates of pot-aſh and ſoda decompoſe it, and nitrates of pot-aſh and ſoda are formed.

20, 21.

The carbonates of pot-aſh and ſoda decompoſe the nitrate of magneſia by *ſuperfluous attraction.* The products are carbonate of magneſia, and nitrates of pot-aſh and ſoda.

XXXIII. AMMONIACO-MAGNESIAN NITRATE.

IT is decompoſed by the twenty-one following, beſide the ſeven ſulphates or ſulphites already mentioned.

1, 2, 3, 4, 5.

The muriates of barites, pot-aſh, ſoda, ſtrontian, and lime, decompoſe it by *ſuperfluous attraction,*

traction, producing the triple muriate of ammonia and magneſia, and nitrate of barites, pot-aſh, ſoda, ſtrontian, or lime, according to the ſalt employed.

6.

Muriate of ammonia. It appears that the action of this is confined to a reciprocal diviſion of the baſes.

The action of the oxigenated muriates is unknown.

7.

Phoſphate of barites. The preſence of this ſalt determines the decompoſition of the ammoniaco-magneſian nitrate ſolely on account of the magneſia. The products are nitrate of barites, and ammoniaco-magneſian phoſphate.

8, 9.

The phoſphates of pot-aſh and ſoda totally decompoſe the ammoniaco-magneſian nitrate, and the reſults muſt be nitrates of pot-aſh and ſoda, and ammoniaco-magneſian phoſphate?

10.

The phoſphate of ammonia decompoſes this ſalt only with reſpect to the magneſia, ſo that after

8, 9, 10.

The phoſphates of pot-aſh, ſoda, and ammonia, decompoſe it by *ſuperfluous attraction*, producing phoſphate of glucine and the reſpective nitrates.

11.

Phoſphate of magneſia. This decompoſition taken for granted?

The action of the phoſphites is nearly ſimilar to that of the phoſphates.

12, 13, 14.

The fluates of pot-aſh, ſoda, and ammonia, decompoſe nitrate of glucine by *ſuperfluous attraction.* The products are fluate of glucine, and the different nitrates.

15, 16, 17.

The borates of pot-aſh, ſoda, and ammonia, act on this ſalt like the three preceding. The products are borate of glucine, and the reſpective nitrates.

18, 19, 20.

The carbonates of pot-aſh, and magneſia, decompoſe the nitrate of glucine by *ſuperfluous attraction.*

attraction. The products are carbonate of glucine, and nitrate of pot-aſh, ſoda, or magneſia.

XXXV. NITRATE OF ALUMINE.

IT is decompoſed by the twenty-three following, beſide the eight ſulphates or ſulphites already mentioned.

1, 2, 3, 4, 5, 6, 7.

The muriates of barites, pot-aſh, ſoda, ſtrontian, lime, ammonia, and glucine, decompoſe the nitrate of alumine by *ſuperfluous attraction*; producing muriate of alumine, and the various nitrates.

The action of the oxigenated muriates is unknown.

8, 9.

The phoſphates of barites and ſtrontian decompoſe the nitrate of alumine, and produce phoſphate of alumine, and nitrate of barites or ſtrontian: *ſuppoſed?*

8, 9, 10.

The phoſphates of pot-aſh, ſoda, and ammonia, decompoſe it by *ſuperfluous attraction*, producing phoſphate of glucine and the reſpective nitrates.

11.

Phoſphate of magneſia. This decompoſition taken for granted?

The action of the phoſphites is nearly ſimilar to that of the phoſphates.

12, 13, 14.

The fluates of pot-aſh, ſoda, and ammonia, decompoſe nitrate of glucine by *ſuperfluous attraction*. The products are fluate of glucine, and the different nitrates.

15, 16, 17.

The borates of pot-aſh, ſoda, and ammonia, act on this ſalt like the three preceding. The products are borate of glucine, and the reſpective nitrates.

18, 19, 20.

The carbonates of pot-aſh, and magneſia, decompoſe the nitrate of glucine by *ſuperfluous attraction*.

attraction. The products are carbonate of glucine, and nitrate of pot-aſh, ſoda, or magneſia.

XXXV. NITRATE OF ALUMINE.

IT is decompoſed by ~~the~~ twenty-three following, beſide the eight ſulphates or ſulphites already mentioned.

1, 2, 3, 4, 5, 6, 7.

The muriates of barites, pot-aſh, ſoda, ſtrontian, lime, ammonia, and glucine, decompoſe the nitrate of alumine by *ſuperfluous attraction*; producing muriate of alumine, and the various nitrates.

The action of the oxigenated muriates is unknown.

8, 9.

The phoſphates of barites and ſtrontian decompoſe the nitrate of alumine, and produce phoſphate of alumine, and nitrate of barites or ſtrontian: *ſuppoſed?*

10.

The phoſphate of magneſia appears to act in the ſame manner?

11, 12, 13.

The phoſphates of pot-aſh, ſoda, ammonia, and glucine, decompoſe it: the products are phoſphate of alumine, and the reſpective nitrates.

14, 15, 16.

The fluates of pot-aſh, ſoda, and ammonia, decompoſe nitrate of alumine by *ſuperfluous attraction*. The products are fluate of alumine, and nitrate of pot-aſh, ſoda, or ammonia.

17, 18, 19.

The borates of pot-aſh, ſoda, and ammonia, act on this ſalt like the preceding, the products being borate of alumine, and different nitrates.

20, 21, 22, 23.

The carbonates of pot-aſh, ſoda, magneſia, and glucine, decompoſe the nitrate of alumine, producing carbonate of alumine, and nitrates with the ſeveral baſes.

XXXVI. Nitrate of Zircone.

IT is decompoſed by the twenty-ſeven following, beſide the eight *ſulphites* already mentioned: (*ſulphates* 0.)

1, 2, 3, 4, 5, 6, 7, 8.

The muriates of barites, pot-aſh, ſoda, ſtrontian, lime, ammonia, glucine, and alumine, decompoſe it by *ſuperfluous attraction.* The products are muriate of zircone, and the different nitrates.

The action of the oxigenated muriates is unknown.

9, 10.

The phoſphates of barites and ſtrontian appear to decompoſe it; and the reſults muſt be phoſphate of zircone, and nitrate of barites or ſtrontian.

11, 12, 13, 14, 15, 16.

The phoſphates of pot-aſh, ſoda, ammonia, magneſia, glucine, and alumine, decompoſe the

nitrate

nitrate of zircone by *ſuperfluous attraction.* The products are phoſphate of zircone, and the different nitrates.

The action of the phoſphites is nearly ſimilar to that of the phoſphates.

17, 18, 19.

The fluates of pot-aſh, ſoda, and ammonia, decompoſe the nitrate of zircone. The products are fluate of zircone, and nitrate of pot-aſh, ſoda, or ammonia.

20, 21, 22.

The borates of pot-aſh, ſoda, and ammonia, act on this ſalt like the preceding, the reſults only differing, being on the one hand borate of zircone, on the other nitrate of pot-aſh, ſoda, or ammonia.

23, 24, 25, 26, 27.

The carbonates of pot-aſh, ſoda, magneſia, glucine, and alumine, decompoſe this ſalt. The products are carbonate of zircone, and the different nitrates.

XXXVII. to XLVII. Incluſively. NITRITES.

THE action of the other ſalts on the nitrites is too little known, to be determined here with accuracy.

XLVIII. MURIATE OF BARITES.

IT is decompoſed by the ten following, beſide the thirteen *ſulphates*, eight *ſulphites*, and ten *nitrates*, already mentioned.

The action of the oxigenated muriates or muriate of barites is unknown.

1, 2, 3.

The phoſphates of pot-aſh, ſoda, and ammonia, are decompoſed by the muriate of barites: the products are phoſphate of barites, and muriate of pot-aſh, ſoda, or ammonia. *Neceſſary attraction.*

The phoſphites act nearly as the phoſphates.

No fluate is capable of decompoſing the muriate of barites.

4, 5.

4, 5, 6, 7.

The borates of pot-aſh, of ſoda, ſuperſaturated with ſoda, and ammonia, decompoſe the muriate with barites: the reſults are borate of barites, and phoſphate of pot-aſh, ſoda, and ammonia. *Neceſſary attraction.*

8, 9, 10.

The carbonates of pot-aſh, ſoda, and ammonia, likewiſe decompoſe it by *Neceſſary attraction.*

XLIX. Muriate of Pot-Ash.

IT is decompoſed by the following, beſide the ſix ſulphates, and nine nitrates, already mentioned.

The action of the oxigenated muriates 0.

The phoſphates and phoſphites have no action on the muriate of pot-aſh.

1.

The fluate of barites decompoſes the muriate of pot-aſh by *ſuperfluous attraction.* The products are fluate of pot-aſh, and muriate of barites.

The action of the carbonates on this ſalt appears to be null, as well as that of the borates.

L. MURIATE OF SODA.

IT is decompoſed by the ſix following, beſide the eight *ſulphates* or *ſulphites*, and the eight *nitrates*, already mentioned.

The action of the oxigenated muriates, 0.

1.

The phoſphate of pot-aſh decompoſes the muriate of ſoda by *ſuperfluous attraction.*

The phoſphites act like the phoſphates on this ſalt.

2, 3.

The fluates of barites and pot-aſh decompoſe the muriate of ſoda by *ſuperfluous attraction.* The reſults are fluate of ſoda, and muriate of barites, and of pot-aſh.

21, 22, 23.

The carbonates of pot-aſh, ſoda, and ammonia, decompoſe the muriate of lime, producing carbonate of lime, and different phoſphates.

LIII. MURIATE OF AMMONIA.

IT is decompoſed by the eleven following, beſide the three *ſulphates*, two *ſulphites*, and two *nitrates*, mentioned above.

The oxigenated muriates 0,

1, 2.

The phoſphates of pot-aſh, and of ſoda, decompoſe the muriate of ammonia by *ſuperfluous attraction*: the products are phoſphate of ammonia, and muriates of pot-aſh, and of ſoda.

The phoſphites, act like the phoſphates on this ſalt.

3, 4, 5, 6.

The fluates of barites, ſtrontian, pot-aſh, and ſoda, decompoſe the muriate of ammonia; producing fluate of ammonia, and different muriates.

7, 8.

The borates of pot-aſh, and ſoda, decompoſe the muriate of ammonia.

The products are { borate of ammonia.
muriate of pot-aſh, or of ſoda.

Superfluous attraction.

9, 10.

The carbonates of pot-aſh and ſoda act in a ſimilar manner.

The products are { carbonate of ammonia.
muriate of pot-aſh, or of ſoda.

11.

The carbonate of magneſia apparently decompoſes the muriate of ammonia, forming two triple ſalts with the two acids?

LIV. MURIATE OF MAGNESIA.

IT is decompoſed by the nineteen following, beſide the four *ſulphates* and the *ſulphites* already mentioned.

The

8, 9, 10, 11.

The borates of pot-aſh, ſoda, ſuperſaturated with ſoda, and ammonia, decompoſe the muriate of ſtrontian; and the decompoſition furniſhes borate of ſtrontian, and different muriates.

12.

The carbonate of barites apparently decompoſes this ſalt?

13, 14, 15.

The carbonates of pot-aſh, ſoda, and ammonia, decompoſe the muriate of ſtrontian: the products are carbonate of ſtrontian, and the different muriates.

LII. Muriate of Lime.

IT is decompoſed by the twenty-three following, beſide the eight *ſulphates*, nine *ſulphites*, *and* ſix *nitrates*, already mentioned.

The action of the oxigenated muriates, O.

1, 2, 3, 4, 5.

The phoſphates of barites, ſtrontian, pot-aſh, ſoda, and ammonia, decompoſe the muriate of lime:

be fluate of magneſia, and the different muriates?

11, 12.

The borates of barites, and ſtrontian, apparently decompoſe the muriate of magneſia?

13, 14, 15, 16.

The borates of pot-aſh, ſoda, ſuper-ſaturated with ſoda, and ammonia, decompoſe the muriate of magneſia; producing borate of magneſia, and different muriates.

17, 18, 19.

The carbonates of pot-aſh, ſoda, and ammonia, decompoſe the muriate of magneſia by *ſuperfluous attraction*: the products are carbonate of magneſia, and the different muriates.

LV. AMMONIACO-MAGNESIAN MURIATE.

IT is decompoſed by the nineteen following beſide the four *ſulphates*, and the four *ſulphites*, already mentioned.

The action of the nitrates and oxigenated muriates 0.

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1, 2, 3.

The phoſphates of barites, ſtrontian, and ammonia, apparently muſt decompoſe the ammoniaco-magneſian muriate only with reſpect to the magneſia; whence would reſult a triple phoſphate, and the different muriates of barites, ſtrontian, and ammonia.

4, 5.

The phoſphates of pot-aſh and ſoda, decompoſe it by *ſuperfluous attraction;* the products are a triple phoſphate, and muriate of pot-aſh, and of ſoda.

The action of the phoſphites is ſimilar to that of phoſphates.

6.

The fluate of barites decompoſes the ammoniaco-magneſian muriate only, as it would ſeem with reſpect to the magneſia?

7, 8, 9.

The fluates of ſtrontian, pot-aſh, and ſod decompoſe it by *ſuperfluous attraction:* th products are the ammoniaco-magneſian triple fluate, and the reſpective muriates.

10.

The fluate of ammonia apparently decompoſes it only in part. No doubt the products are a triple fluate, and muriate of ammonia?

11, 12, 13.

The borates of barites, ſtrontian, and ammonia, act on this ſalt as the fluates No. 7, 8, 9.

14.

The magneſio-calcareous borate, though its affinities are little known, apparently effects a ſort of decompoſition with this ſalt, from which may reſult an ammoniaco-magneſian borate, and a magneſio-calcareous muriate?

15.

The fluate of ammonia decompoſes this triple ſalt in reſpect to a little magneſia, and perhaps two triple ſalts are formed.

16, 17, 18, 19.

The carbonates of pot-aſh, ſoda, and ammonia, decompoſe the ammoniaco-magneſian muriate, producing a triple carbonate, and the reſpective muriates.

LVI. MURIATE OF GLUCINE.

IT is decompoſed by the twenty-four following, beſide the five *ſulphates* or *ſulphites*, and the two *nitrates*, already mentioned.

The oxigenated muriates 0.

1, 2, 3.

The phoſphates of barites, ſtrontian, and magneſia, decompoſe the muriate of glucine by *ſuperfluous attraction*; the products are phoſphate of glucine, and the reſpective muriates?

4, 5, 6.

The phoſphates of pot-aſh, ſoda, and ammonia, decompoſe this muriate by *ſuperfluous attraction*: the products are phoſphate of glucine, and the different muriates.

The phoſphites would appear to act like the preceding.

7, 8, 9, 10, 11, 12.

The fluates of barites, pot-aſh, ſoda, ſtrontian, magneſia, and ammonia, decompoſe this ſalt: the products are fluate of glucine, and muriates, differing according to the decompoſing ſalt.

13, 14, 15.

The borates of barites, ſtrontian, and magneſia, probably decompoſe the muriate of glucine: the reſults muſt be borate of glucine, and the reſpective muriates?

16, 17, 18.

The borates of pot-aſh, ſoda, and ammonia, are decompoſed by the muriate of glucine: the reſults are borate of glucine, and the different muriates.

19, 20.

The carbonates of lime and magneſia would appear to decompoſe the muriate of glucine, producing carbonate of glucine, and the different muriates.

21, 22, 23, 24.

The carbonates of ſtrontian, pot-aſh, ſoda, and ammonia, decompoſe the muriate of glucine by *ſuperfluous attraction*, producing carbonate of glucine, and the reſpective muriates

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LVII. MURIATE OF ALUMINE.

IT is decompoſed by the twenty-five following, beſide the nine *ſulphates* or *ſulphites*, and the *nitrate*, already mentioned.

Oxigenated muriates 0.

1, 2, 3.

The phoſphates of barites, ſtrontian, and magneſia, ſeem to decompoſe the muriate of alumine?

4, 5, 6, 7.

The phoſphates of pot-aſh, ſoda, ammonia, and glucine decompoſe it: the products are phoſphate of alumine, and the reſpective muriates.

The action of the phoſphites is nearly equa to that of the phoſphates.

8,

8, 9, 10, 11, 12, 13.

The fluates of barites, ſtrontian, magneſia, pot-aſh, ſoda, and ammonia, decompoſe the muriate of alumine, and different muriates are formed.

14, 15.

The borates of barites and ſtrontian ſeem to effect the decompoſition of this ſalt?

16, 17, 18, 19.

The borates of magneſia, pot-aſh, ſoda, and ammonia, decompoſe the muriate of alumine by *ſuperfluous attraction:* the products are borate of alumine, and the different muriates.

20, 21, 22, 23, 24, 25.

The carbonates of barites, lime, pot-aſh, ſoda, magneſia, and ammonia, decompoſe the muriate of alumine, carbonate of alumine, and the different muriates, being formed.

The decompoſition by carbonate of barites (20,) ſeems doubtful, or is only preſumed?

LVIII.

LVIII. MURIATE OF ZIRCONE.

IT is decompoſed by the twenty-ſix following, beſide the ſeven *ſulphites* already mentioned.

Sulphates, nitrates, and oxigenated muriates, 0.

1, 2, 3, 4, 5, 6, 7, 8.

The phoſphates of barites, ſtrontian, pot-aſh, ſoda, ammonia, magneſia, glucine, and alumine, decompoſe the muriate of zircone. The reſults are phoſphate of zircone, and muriates differing according to the decompoſing ſalt.

The phoſphites exert on muriate of zircone an action analogous to that of the phoſphates.

9, 10, 11, 12, 13, 14.

The fluate of barites, ſtrontian, magneſia, pot-aſh, ſoda, and ammonia, decompoſe the muriate of zircone: the products are fluate of zircone, and very different muriates.

15, 16.

The borates of barites and ſtrontian ſeem to decompoſe it?

17, 18, 19, 20.

The borates of magneſia, pot-aſh, ſoda, and ammonia, decompoſe it, producing borate of zircone, and the different muriates.

21.

The carbonate of barites is preſumed to decompoſe it?

22, 23, 24, 25, 26.

The carbonates of lime, pot-aſh, ſoda, magneſia, and ammonia, decompoſe it.

LIX. Muriate of Silex.

IT is decompoſed by the eighteen following, excluſive of the action of the preceding ſalts, which has not yet been examined ſufficiently to be mentioned.

Oxigenated muriates 0.

1, 2, 3, 4.

The phoſphates of pot-aſh, ſoda, ammonia, and magneſia, decompoſe it by *ſuperfluous attraction.*

attraction. The reſults are phoſphate of ſilex, and muriate of pot-aſh, ſoda, ammonia, and magneſia.

The phoſphites act like the phoſphates.

5, 6, 7.

The fluates of ſtrontian, magneſia, and pot-aſh, ſeem to decompoſe this ſalt?

8, 9.

The fluates of ſoda and ammonia decompoſe the muriate of ſilex: the products are fluate of ſilex, and muriates of ſoda and ammonia.

10, 11, 12.

The borates of pot-aſh, ſoda, and ammonia, decompoſe the muriate of ſilex by *ſuperfluous attraction*, producing borate of ſilex, and the reſpective muriates.

13, 14, 15, 16, 17, 18.

The carbonates of barites, lime, pot-aſh, ſoda, ammonia, and magneſia, decompoſe the muriate of ſilex, and muriates are obtained, differing according to the carbonates employed, without carbonate of ſilex being formed.

LX. to LXVIII. incluſively.

OXIGENATED MURIATES.

THE nine ſpecies of oxigenated or ſuper-oxigenated muriates, are yet too little known for it to have been poſſible to appreciate the effects of double attraction between them and all the other ſpecies of ſalts.

Even the decompoſitions of which the ſuper-oxigenated muriate of pot-aſh, the only one known, is ſuſceptible, have not yet been pointed out.

LXIX. PHOSPHATE OF BARITES.

IT is decompoſed by the two following, beſide the thirteen *ſulphates*, three *ſulphites*, ſix *nitrites*, ſix nitrates, and ſeven *muriates*, already noticed.

1.

Carbonate of pot-aſh. The products are carbonate of barites, and phoſphate of pot-aſh: the double attraction is neceſſary.

2.

Carbonate of ſoda. The products are carbonate of barites, and phoſphate of ſoda: the double attraction is neceſſary.

LXX. Phosphate of Lime.

IT is decompoſed by the five following:

1, 2, 3, 4, 5.

Phoſphite of barites?
Fluate of barites;
Fluate of pot-aſh;
Fluate of ſoda;
Borate of barites.

LXXI. Acid Phosphate of Lime.

IT is decompoſed by the eighteen following, beſide the nine *ſulphates* or *ſulphites* already mentioned.

Nitrates, nitrites, muriates, oxigenated muriates 0.

1. Phoſ-

1.

Phoſphite of lime: the exceſs of the phoſphoric acid combines with the lime, and ſets the phoſphoric acid free.

2.

Phoſphite of barites.

3.

Phoſphite of ſtrontian: with this the ſame thing occurs as with the phoſphite of lime.

4, 5, 6, 7.

Fluates of barites, pot-aſh, ſoda, and ammonia.

8, 9, 10.

Borates of barites, pot-aſh, and ſoda.

11, 12, 13, 14, 15, 16, 17, 18.

Carbonates of barites, ſtrontian, lime, pot-aſh, ſoda, magneſia, ammonia, and glucine. Theſe eight ſalts, that is to ſay, all the carbonates, only ſaturate the exceſs of phoſphoric acid, whence reſult two different phoſphates unleſs when the carbonate of lime is employed); namely, a phoſphate with the baſe of the carbonate employed, and phoſphate of lime.

LXXII. PHOSPHATE OF STRONTIAN.

IT is decompoſed by the thirteen following, beſide the five *ſulphates* or *ſulphites*, four *nitrates*, and ſix *muriates*, already mentioned.

1, 2.

Phoſphites of barites and pot-aſh.

3, 4, 5, 6.

Fluates of barites, pot-aſh, ſoda, and ammonia.

7, 8, 9.

Borates of barites, pot-aſh, and ſoda.

10, 11, 12, 13.

Carbonates of barites, lime, pot-aſh, and ſoda.

LXXIII. PHOSPHATE OF POT-ASH.

IT is decompoſed by the eight following, beſide the ſixteen *ſulphates or ſulphites*, ten *nitrates*, and eleven *muriates*, mentioned above. (Oxigenated muriates and nitrates 0.)

1, 2.

Phoſphites of lime and barites.

3, 4.

Fluates of lime and barites.

5, 6.

Borates of lime and barites.

7, 8.

Carbonates of barites and lime.

LXXIV. PHOSPHATE OF SODA.

IT is decompoſed by the twelve following, beſide the fifteen *ſulphates* or *ſulphites*, nine *nitrates*, and ten *muriates*, mentioned above.

1, 2.

1, 2, 3.

Phoſphites of lime, barites, and pot-aſh.

4, 5, 6.

Fluates of lime, barites, and pot-aſh.

7, 8, 9.

Borates of lime, barites, and pot-aſh.

10, 11, 12.

Carbonates of barites, lime, and pot-aſh.

LXXV. PHOSPHATE OF AMMONIA.

IT is decompoſed by the twenty-three following, beſide the fifteen *ſulphates* and *ſulphites*, eight *nitrates*, and nine *muriates*, already mentioned.

1, 2, 3, 4, 5, 6.

Phoſphites of lime, barites, ſtrontian, magneſia, pot-aſh, and ſoda.

7, 8, 9, 10, 11, 12.

Fluates of lime, barites, ſtrontian, magneſia, pot-aſh, and ſoda.

13, 14, 15, 16, 17, 18,

Borates of lime, barites, ſtrontian, magneſia, pot-aſh, and ſoda.

19, 20, 21, 22, 23.

Carbonates of barites, ſtrontian, lime, pot-aſh, and ſoda.

LXXVI. PHOSPHATE OF SODA AND AMMONIA.

IT is decompoſed by the nineteen following, beſide the five *ſulphates* and *ſulphites*, and the *nitrate* already mentioned, (muriates 0.)

1, 2, 3, 4.

Phoſphites of lime, barites, pot-aſh, and ſoda, with reſpect to the ammonia.

5, 6,

5, 6, 7, 8, 9.

Fluates of lime, barites, ſtrontian, pot-aſh, and ſoda, with reſpect to the ammonia.

10, 11, 12, 13, 14, 15.

Borates of lime, barites, ſtrontian, pot-aſh, ſoda, and ſuper-ſaturated with ſoda.

16, 17, 18, 19.

Carbonates of barites, lime, pot-aſh, and ſoda.

LXXVII. PHOSPHATE OF MAGNESIA.

IT is decompoſed by the twenty followin[illegible] beſides the ſeven *ſulphates* and *ſulphites*, thre[illegible] *nitrates*, and four *muriates*, already mentione[illegible]

1, 2, 3, 4, 5.

Phoſphites of lime, barites, ſtrontian, p[illegible] aſh, and ſoda.

6, 7, 8, 9, 10, 11.

Fluates of lime, barites, ſtrontian, pot-aſh, ſoda, and ammonia.

12, 13, 14, 15, 16.

Borates of lime, barites, ſtrontian, pot-aſh, and ſoda.

17, 18, 19. 20.

Carbonates of ſtrontian, Lime, pot-aſh, and ſoda.

LXXVIII. AMMONIACO-MAGNESIAN PHOSPHATE.

IT is decompoſed by the nineteen following, beſide the ſeven *ſulphates* and *ſulphites* already mentioned.

(Nitrates and muriates 0.)

1, 2, 3, 4, 5.

Phoſphites of lime, barites, ſtrontian, pot-aſh, and ſoda.

6, 7, 8, 9, 10.

Fluates of lime, barites, ſtrontian, pot-aſh, and ſoda.

11, 12, 13, 14, 15.

Borates of lime, barites, ſtrontian, pot-aſh, and ſoda.

16, 17, 18, 19.

Carbonates of ſtrontian, lime, pot-aſh, and ſoda.

LXXIX. PHOSPHATE OF GLUCINE.

IT is decompoſed by the twenty-ſeven following, beſide the ten *ſulphates*, and *ſulphites*, two *nitrates*, and two *muriates*, already noticed.

1, 2, 3, 4, 5, 6, 7.

Phoſphites of lime, barites, ſtrontian, magneſia, pot-aſh, ſoda, and ammonia.

8, 9, 10, 11, 12, 13, 14.

Fluates of lime, barites, ſtrontian, magneſia, pot-aſh, ſoda, and ammonia.

15, 16, 17, 18, 19, 20, 21.

Borates of lime, barites, ſtrontian, magneſia, pot-aſh, ſoda, and ammonia.

22, 23, 24, 25, 26, 27.

Carbonates of barites, ſtrontian, lime, pot-aſh, ſoda, and ammonia.

LXXX. PHOSPHATE OF ALUMINE.

IT is decompoſed by the thirty following, beſide the eleven *ſulphates* and *ſulphites*, one *nitrate*, and one *muriate*, already mentioned.

1, 2, 3, 4, 5, 6, 7.

Phoſphites of lime, barites, ſtrontian, magneſia, pot-aſh, ſoda, and ammonia.

8, 9, 10, 11, 12, 13, 14, 15.

Fluates of lime, barites, ſtrontian, magneſia, pot-aſh, ſoda, ammonia, and glucine.

16, 17, 18, 19, 20, 21, 22.

Borates of lime, barites, ſtrontian, magneſia, pot-aſh, ſoda, and ammonia.

23, 24, 25, 26, 27, 28, 29, 30.

Carbonates of barites, ſtrontian, lime, pot-aſh, ſoda, magneſia, ammonia, and glucine.

LXXXI. PHOSPHATE OF ZIRCONE.

IT is decompoſed by the thirty-four following, beſide the ten *ſulphites* already mentioned (ſulphates, nitrates, and muriates, 0.)

1, 2, 3, 4, 5, 6, 7, 8, 9.

Phoſphites of lime, barites, ſtrontian, magneſia, pot-aſh, ſoda, ammonia, glucine, and alumine.

10, 11, 12, 13, 14, 15, 16, 17.

Fluates of lime, barites, ſtrontian, magneſia, pot-aſh, ſoda, ammonia, and glucine.

18, 19, 20, 21, 22, 23, 24, 25.

Borates of lime, barites, ſtrontian, magneſia, pot-aſh, ſoda, ammonia, and glucine.

26, 27, 28, 29, 30, 31, 32, 33, 34.

Carbonates of ſtrontian, lime, pot-aſh, ſoda, ammonia, magneſia, ammoniaco-magneſian, glucine, and alumine.

LXXXII. PHOSPHATE OF SILEX.

IT is decompoſed by the thirty-nine following, beſide one *ſulphate* already mentioned, (ſulphites, nitrates, and muriates, 0.)

1, 2, 3, 4, 5, 6, 7, 8, 9.

Phoſphites of lime, barites, ſtrontian, magneſia, pot-aſh, ſoda, ammonia, alumine, and glucine.

10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20.

Fluates of lime, barites, ſtrontian, magneſia, pot-aſh, ſoda, ammonia, alumine, glucine, and two triple.

21, 22, 23, 24, 25, 26, 27, 28, 29, 30.

Borates of lime, barites, ſtrontian, magneſia, pot-aſh, ſoda, ammonia, alumine, glucine, and zircone.

31, 32, 33, 34, 35, 36, 37, 38, 39.

Carbonates of barites, ſtrontian, lime, pot-aſh, ſoda, ammonia, magneſia, alumine, and glucine,

LXXXIII, to XCIII, Incluſively.

THE eleven ſpecies of phoſphites, which I have deſcribed, have not yet been ſufficiently examined, to render it poſſible to exhibit any thing like an exact ſeries of the double decompoſitions, which they are capable of undergoing with the fluates, borates, and carbonates, In the ſeven preceding genera of ſalts the action of moſt of the phoſphites, on the ſulphates, ſulphites, nitrates, nitrites, muriates, and phoſphates, has appeared. To theſe decompoſitions it is eaſiy to add thoſe of the phoſphites by the fluates, borates, carbonates, with regard to which their capability of being altered muſt nearly approach what has been attributed to the phoſphates: but theſe efforts, probable as they are, not having been verified by experiments, I have not thought it proper to give them here at large, as I have done with the preceding, and ſhall do with the ſubſequent genera.

XCIV. FLUATE OF LIME.

IT is decompoſed by the two following, beſide the ten *phoſphates* already mentioned, (ſulphates, ſulphites, nitrates, nitrites, muriates, and oxigenated muriates, 0.)

1.

Carbonate of pot-aſh.

2.

Carbonate of ſoda.

XCV. FLUATE OF BARITES.

IT is decompoſed by the eight following, beſide the ſixteen *ſulphates* and *ſulphites*, three *nitrates*,

nitrates, ten *muriates,* and twelve *phoſphates,* already mentioned.

1, 2, 3, 4.

Borates of lime, pot-aſh, ſoda, ſuperſaturated of ſoda.

5, 6, 7, 8.

Carbonate of lime, pot-aſh, ſoda, and ammonia.

XCVI. FLUATE OF STRONTIAN.

IT is decompoſed by the ſeven following, beſides the fourteen *ſulphates* and *ſulphites,* eight *nitrates,* nine *muriates,* and eight *phoſphates,* already mentioned.

1, 2, 3.

Borates of barites, pot-aſh, and ſoda.

4, 5, 6, 7.

Carbonates of lime, pot-aſh, ſoda, and ammonia.

XCVII. FLUATE OF MAGNESIA.

IT is decompoſed by the ten following, beſide the eight *ſulphates* and *ſulphites*, one *nitrate;* ſix *muriates*, five *phoſphates*, already mentioned.

1, 2, 3, 4, 5.

Borates of lime, barites, ſtrontian, pot-aſh, and ſoda.

6, 7, 8, 9, 10.

Carbonates of ſtrontian, lime, pot-aſh, ſoda, and ammonia.

XCVIII. FLUATE OF POT-ASH.

IT is decompoſed by the three following, beſide the ten *ſulphates and ſulphites*, ten *nitrates*, eleven *muriates*, and twelve *phoſphates*, already noticed.

1, 2, 3.

Borates of lime, barites, and ſtrontian.

XCIX. FLUATE OF SODA.

IT is decompoſed by the ſix following, beſide the nine *ſulphates* and *ſulphites*, nine *nitrates*, ten *muriates*, and ten *phoſphates*, already mentioned.

1, 2, 3, 4.

Borates of lime, barites, ſtrontian, and pot-aſh.

5, 6.

Carbonates of pot-aſh and ammonia?

C. SILICEOUS FLUATE OF SODA.

THE manner in which it acts with the other ſalts is not known.

CI. FLUATE OF AMMONIA.

IT is decompoſed by the eight following, beſide the nine *ſulphates* and *ſulphites*, eight *nitrates*,

trates, eight *muriates*, and ſeven *phoſphates*, already mentioned.

1, 2, 3, 4, 5.

Borates of lime, barites, ſtrontian, pot-aſh, and ſoda.

6, 7, 8.

Carbonates of lime, pot-aſh, and ſoda.

CII. AMMONIACO-MAGNESIAN FLUATE.

IT is decompoſed by the ten following; its action on the preceding has not been examined.

1, 2, 3, 4, 5.

Borates of lime, barites, ſtrontian, pot-aſh, and ſoda.

6, 7, 8, 9, 10.

Carbonates of ſtrontian, lime, pot-aſh, ſoda, and ammonia.

CIII.

CIII. AMMONIACO-SILICEOUS FLUATE.

ITS action on the other ſalts is not known.

CIV. FLUATE OF GLUCINE.

IT is decompoſed by the fourteen following, beſide the four *ſulphates* or *ſulphites*, and three *phoſphates*, already mentioned.

1, 2, 3, 4, 5, 6, 7.

Borates of lime, barites, ſtrontian, magneſia, pot-aſh, ſoda, and ammonia.

8, 9, 10, 11, 12, 13, 14.

Carbonates of barites, ſtrontian, lime, pot-aſh, ſoda, magneſia, and ammonia.

CV. FLUATE OF ALUMINE.

IT is decompoſed by the ſixteen following, beſide the *phoſphates* already mentioned.

1, 2,

1, 2, 3, 4, 5, 6, 7, 8.

Borates of lime, barites, ſtrontian, magneſia, pot-aſh, ſoda, ammonia, and glucine.

9, 10, 11, 12, 13, 14, 15, 16.

Carbonates of barites, ſtrontian, lime, pot-aſh, ſoda, magneſia, ammonia, and glucine.

CVI. FLUATE OF ZIRCONE.

IT is decompoſed by the eighteen following: its action on the preceding ſalts is not known.

1, 2, 3, 4, 5, 6, 7, 8, 9.

Borates of lime, barites, ſtrontian, magneſia, pot-aſh, ſoda, ammonia, glucine, and alumine.

10, 11, 12, 13, 14, 15, 16, 17, 18.

Carbonates of barites, ſtrontian, lime, pot-aſh, ſoda, magneſia, ammonia, alumine, and glucine.

CVII. Fluate of Silex.

IT is decompoſed by the twenty following, and is not decompoſed by any of the preceding neutral ſalts.

1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11.

Borates of lime, barites, ſtrontian, magneſia, pot-aſh, ſoda, ſuperſaturated of ſoda, ammonia, glucine, alumine, and zircone.

12, 13, 14, 15, 16, 17, 18, 19, 20.

Carbonates of barites, ſtrontian, lime pot-aſh, ſoda, ammonia, magneſia, glucine, and alumine.

CVIII. Borate of Lime.

IT is not decompoſed by any of the following, but it is by ten *phoſphates*, and ten *fluates* already noticed.

CIX. BORATE OF BARITES.

IT is not decompoſed by any of the following, but by eleven *ſulphates* or *ſulphites*, one *nitrate*, four *muriates*, twelve *phoſphates*, and ten *fluates*, already mentioned.

CX. BORATE OF STRONTIAN.

IT is decompoſed by ten *ſulphates* or *ſulphites*, three *nitrates*, four *muriates*, ſeven *phoſphates*, and nine *fluates*, already mentioned.

CXI. BORATE OF MAGNESIA.

IT is decompoſed by the five following, beſide the ſix *ſulphates* or *ſulphites*, two *muriates*, five *phoſphates*, and four *fluates*, already mentioned.

1, 2, 3, 4, 5.

Carbonates of barites, ſtrontian, lime, potaſh, and ſoda.

CXII. Magnesio-Calcareous Borate.

ITS action on the other ſalts is not well known: it is decompoſed by one muriate already mentioned.

CXIII. Borate of Pot-Ash.

IT is not decompoſed by any of the following, but is by thirteen *ſulphates* or *ſulphites*, ten *nitrates*, nine *muriates*, ten *phoſphates*, and ten *fluates*, already mentioned.

CXIV. Borate of Soda.

IT is decompoſed by the carbonate of potaſh, beſide the eleven *ſulphates* or *ſulphites*, nine *nitrates*, eight *muriates*, eight *phoſphates*, and eight *fluates*, already mentioned.

CXV. Supersaturated Borate of Soda.

IT acts like the preceding, and is decompoſed like it.

CXVI. BORATE OF AMMONIA.

IT is decompoſed by the ſix following, beſide the ten *ſulphates* or *ſulphites*, ſeven *nitrates*, eight *muriates*, four *phoſphates*, and four *fluates*, already mentioned.

1, 2, 3, 4, 5, 6.

Carbonates of barites, ſtrontian, lime, potaſh, ſoda, and magneſia.

CXVII. AMMONIACO-MAGNESIAN BORATE.

THE manner in which this ſalt acts upon others has not yet been examined.

CXVIII. BORATE OF GLUCINE.

IT is decompoſed by the ſeven following, beſide the two *phoſphates*, and three *fluates*, already mentioned.

1, 2, 3, 4, 5, 6, 7.

Carbonates of barites, ſtrontian, lime, potaſh, ſoda, magneſia, and ammonia.

CXIX. BORATE OF ALUMINE.

IT is decompoſed by the eight following, beſide one *phoſphate*, and two *fluates*, already mentioned.

1, 2, 3, 4, 5, 6, 7, 8.

Carbonates of barites, ſtrontian, lime, potaſh, ſoda, magneſia, ammonia, and glucine.

CXX. BORATE OF ZIRCONE.

IT is decompoſed by the nine following, beſide one *phoſphate*, and one *fluate*, already mentioned.

1, 2, 3, 4, 5, 6, 7, 8, 9.

Carbonates of barites, ſtrontian, lime, potaſh, ſoda, magneſia, ammonia, glucine, and alumine.

CXXI. Borate of Silex.

IT is decompoſed by the ten following. The preceding ſalts do not appear to have any action on it.

1, 2, 3, 4, 5, 6, 7, 8, 9, 10.

Carbonates of barites, ſtrontian, lime, potaſh, ſoda, magneſia, ammonia, glucine, alumine, and zircone.

CXXII, to CXXXIV, Incluſively.

THE fourteen ſpecies of earthy and alkaline carbonates diſtinguiſhed and deſcribed in this fifth ſection, having been treated of in the CXXI preceding numbers, and being the laſt of all the ſaline ſubſtances, nothing more remains to be ſaid reſpecting their re-actions, and double decompoſitions.

ARTICLE XVI.

Recapitulation of the Compoſition of the One Hundred and Thirty-Five Species of Salts, or Table of the Proportions of their conſtituent Principles.

1. AFTER having peruſed all that has preceded this part of my ſyſtem, the reader muſt be ſufficiently advanced in his ſtudy of the ſcience of chemiſtry, readily to conceive, that an accurate knowledge of the phenomena of this ſcience depends greatly on a determination of the reſpective quantities of the principles that enter into the formation of compounds. Accordingly, ſince chemiſtry has changed its appearance, ſince its means of analyſis have been increaſed, and ſince its inſtruments have acquired ſuch a great degree of perfection, compared with what they poſſeſſed thirty years ago, the principal object of the labours of chemiſts has been, to inveſtigate the proportions of the elements, that conſtituted the different compounds on which their attention was employed. Among the uſeful reſults, which reſearches of this kind have furniſhed, the ſalts particularly

offer ſome of great importance, either for effecting their decompoſition with advantage, knowing their nature with preciſion, or appreciating the effects in all the caſes in which they are employed.

2. I have taken care, in the hiſtory of each particular ſpecies, to exhibit this proportion of its principles, after having pointed out the method that has been purſued for analyzing it. The enunciation of this has appeared to me ſo important for completing the chemical hiſtory of ſalts, that I have inſerted it at the end of this hiſtory, that it may become as it were its moſt prominent point, and natural concluſion. But the utility of this reſult of the analyſis of ſalts muſt become ſtill much greater, by bringing together the proportions of the conſtituent principles of each ſalt, ſince it will enable us to compare the reſpective quantities of the ſaline principles, the difference of the reciprocal ſaturabilities of acids by the baſes, and of baſes by the acids, the relation of theſe proportions to the degrees of attraction that unite them, either in the different ſpecies of the ſame genus, or in ſpecies of different genera analogous to each other with reſpect to their baſes.

3. Beſides which, this table exhibiting at a ſingle view the facts ſcattered through a very extenſive part of this work, it will ſhow what has been completed in this kind of analyſis, and what remains to be done. By com-

paring it with that of the compoſition of ſome of the principal ſpecies of ſalts given by Bergmann in his diſſertation on the analyſis of waters, it will be capable of ſhowing the progreſs made in chemiſtry by thoſe philoſophers, who have purſued the new path barely opened by the illuſtrious Swediſh profeſſor. I ſhall proceed to give it, adopting for the 135 ſpecies of ſalts the ſame order in which I have already placed and deſcribed them, only adding before each of them a number, which will point out, for this ſixteenth article of the fifth ſection, the numerical ſeries, which I have purſued in each diviſion of this work.

4. *Sulphate of Barites.*

A. Natural	Sulphuric acid	13
	Barites - -	84
	Water - -	3
B. Artificial	Sulphuric acid	33
	Barites - -	64
	Water - -	3

5. *Sulphate of Pot-Aſh.*

Sulphuric acid -	40
Pot-aſh - - -	52
Water - - -	8

6. *Acid Sulphate of Pot-Aſh.*

Sulphate of pot-aſh	67
Sulphuric acid -	33

7. *Sulphate of Soda.*

Sulphuric acid -	27
Soda - - -	15
Water - - -	58

8. *Sulphate of Strontian.*

Sulphuric acid -	46
Strontian - - -	54

9. *Sulphate of Lime.*

Sulphuric acid -	46
Lime - - - -	32
Water - - - -	22

10. *Sulphate of Ammonia.*

Sulphuric acid -	42
Ammonia - -	40
Water - - -	18

11. *Sulphate of Magneſia.*

Sulphuric acid -	33
Magneſia - -	19
Water - - -	48

12. *Ammoniaco-Magneſian Sulphate.*

Sulphate of magneſia	68
Sulphate of ammonia	32

13. *Sulphate of Glucine.*

Proportions unknown.

14. *Sulphate of Alumine.*

Neutral	ſulphuric acid	50
	Alumine -	50

15. *Acid Sulphate of Alumine, and of Pot-Aſh, or Ammonia, or Alum.*

Sulphate of alumine	49
Sulphate of pot-aſh	7
Water - - - -	44

16. *Saturated triple Sulphate of Alumine.*

Proportions not exactly known.

17. *Sulphate*

17. *Sulphate of Zircone.*

Proportions unknown.

18. *Sulphite of Barites.*

Sulphureous acid -	39
Barites - - -	59
Water - - -	2

19. *Sulphite of Lime.*

Sulphureous acid -	48
Lime - - - -	45
Water - - -	5

20. *Sulphite of Pot-Aſh.*

Proportions not yet known.

21. *Sulphite of Soda.*

Sulphureous acid -	31
Soda - - - -	18
Water - - -	51

22. *Sulphite of Strontian.*

Proportions not yet known.

23. *Sulphite*

23. *Sulphite of Ammonia.*

Sulphureous acid	60
Ammonia -	29
Water - -	11

24. *Sulphite of Magneſia.*

Sulphureous acid	39
Magneſia -	16
Water - -	45

25. *Ammoniaco-magneſian Sulphite.*

Proportions unknown.

26. *Sulphite of Glucine.*

Proportions unknown.

27. *Sulphite of Alumine.*

Sulphureous acid	32
Alumine - -	44
Water -	24

28. *Sulphite of Zircone*

Proportions unknown.

29. *Nitrate of Barites.*

Nitric acid	-	38
Barites	- -	50
Water	- -	12

30. *Nitrate of Pot-Aſh.*

Nitric acid	-	33	Bergmann.
Pot-aſh	- -	49	
Water	- -	18	

Nitric acid	-	30	Kirwan.
Pot-aſh	- -	63	
Water	- -	7	

31. *Nitrate of Soda.*

Nitric acid	-	29
Soda	- -	50
Water	- -	21

32 *Nitrate of Strontian.*

Nitric acid		48,4
Strontian	-	47,6
Water	- -	4,0

33. *Nitrate*

33. *Nitrate of Lime.*

Nitric acid	43
Lime	32
Water	25

34. *Nitrate of Ammonia.*

Nitric acid	46
Ammonia	40
Water	14

35. *Nitrate of Magneſia.*

Nitric acid	43
Magneſia	27
Water	30

36. *Ammoniaco-magneſian Nitrate.*

Nitrate of ammonia	22
Nitrate of magneſia	78

37. *Nitrate of Glucine.*

Proportions not aſcertained.

38. *Nitrate of Alumine.*

Proportions unknown.

39. *Nitrate*

39 *Nitrate of Zircone.*

Proportions unknown.

40. *Nitrite of Barites.*

41. *Nitrite of Pot-Aſh.*

42. *Nitrite of Soda.*

43. *Nitrite of Strontian.*

44. *Nitrite of Lime.*

45. *Nitrite of Ammonia.*

46. *Nitrite of Magneſia.*

47. *Ammoniaco-magneſian Nitrite.*

48. *Nitrite of Glucine.*

49. *Nitrite of Alumine.*

50. *Nitrite of Zircone.*

No nitrite has yet been carefully examined; and we know not the proportions of the principles of any one.

51. *Muriate of Barites.*

Muriatic acid -	24
Barites - -	60
Water - -	16

52. *Muriate*

52. *Muriate of Pot-Aſh.*

Muriatic acid	-	30
Pot-aſh	- -	62
Water	- -	8

53. *Muriate of Soda.*

Muriatic acid		52	Bergmann.
Soda	- -	42	
Water	- -	6	

Muriatic acid		33	Kirwan.
Soda	- -	50	
Water	- -	17	

54. *Muriate of Strontian.*

Muriatic acid		23,6
Strontian	-	36,4
Water	- -	40,0

55. *Muriate of Lime.*

Muriatic acid	-	31
Lime	- -	44
Water	- -	25

55. *Muriate*

56. *Muriate of Ammonia.*

Muriatic acid -	52
Ammonia - -	40
Water - -	8

57. *Muriate of Magneſia.*

Muriatic acid -	34
Magneſia - -	41
Water - -	25

58. *Ammoniaco-magneſian Muriate.*

Muriate of ammonia	27
Muriate of magneſia	73

59. *Muriate of Glucine.*

Proportions unknown.

60. *Muriate of Alumine.*

Proportions unknown.

61. *Muriate of Zircone.*

Proportions unknown.

62. *Muriate of Silex.*

Proportions unknown.

63. *Super-oxigenated Muriate of Barites.*

Proportions unknown.

64. *Super-oxigenated Muriate of Pot-Aſh.*

Muriate of pot-aſh	67
Oxigen - -	33

65. *Super-oxigenated Muriate of Soda,*

66. *Super-oxigenated Muriate of Strontian.*

67. *Super-oxigenated Muriate of Lime.*

68. *Super-oxigenated Muriate of Magneſia.*

69. *Super-oxigenated Muriate of Glucine.*

70. *Super-oxigenated Muriate of Alumine.*

71. *Super-oxigenated Muriate of Zircone.*

The exiſtence of the ſuper-oxigenated muriates, in general, being at preſent little more than conjectured, we cannot yet have any idea of the proportions of their principles.

72. *Phoſphate of Barites.*

Proportions unknown.

73. *Phoſphate of Strontian.*

Phoſphoric acid	41,24
Strontian -	58,76

74. *Phoſphate of Lime.*

Phoſphoric acid	41
Lime - -	59

75. *Acid Phoſphate of Lime.*

Phoſphoric acid	54
Lime - -	46

76. *Phoſphate of Pot-Aſh.*

Proportions unknown.

77. *Phoſphate of Soda.*

Proportions unknown.

78. *Phoſphate of Ammonia.*

Proportions unknown.

79. *Phoſphate of Soda and Ammonia.*

Phoſphoric acid	32
Soda - -	24
Ammonia - -	19
Water - -	25

80. *Phoſphate of Magneſia.*

Proportions unknown.

81. *Ammoniaco-magneſian Phoſphate.*

Magneſian phoſphate	50
Ammoniacal phoſphate	25
Water - -	25

82. *Phoſphate of Glucine.*

Proportions unknown.

83. *Phoſphate of Alumine.*

Proportions unknown.

84. *Phoſphate of Zircone.*

Proportions unknown.

85. *Phoſphate of Silex.*

Proportions unknown.

86. *Phoſphite of Lime.*

Phoſphoreous acid	34
Lime - -	51
Water - -	15

87. *Phoſphite of Barites.*

Phoſphoreous acid	41,7
Barites - -	51,3
Water - -	7,0

88. *Phoſphite of Strontian.*

Proportions unknown.

89. *Phoſphite of Magneſia.*

Phoſphoreous acid	44
Magneſia -	20
Water - -	36

90. *Phoſphite of Pot-Aſh.*

Phoſphoreous acid	39,5
Pot-aſh - -	49,5
Water - -	11,0

91. *Phoſphite of Soda.*

Phoſphoreous acid	16,3
Soda - -	23,7
Water - -	60,0

92. *Phoſphite of Ammonia.*

Phoſphoreous acid	26
Ammonia - -	51
Water - -	23

93. *Ammoniaco-magneſian Phoſphit*

Proportions unknown.

94. *Phoſphite of Glucine.*

Proportions unknown.

95. *Phoſphite of Alumine.*

Proportions unknown,

96. *Phoſphite of Zircone.*

Proportions unknown.

97. *Fluate of Lime.*

Proportions unknown.

98. *Fluate of Barites.*

99. *Fluate of Strontian.*

100. *Fluate of Magneſia.*

101. *Fluate of Pot-Aſh.*

102. *Siliceous Fluate of Pot-Aſh.*

103. *Fluate of Soda.*

104. *Siliceous Fluate of Soda.*

105. *Fluate of Ammonia.*

106. *Ammoniaco-magneſian Fluate.*

107. *Ammoniaco-ſiliceous Fluate.*

108. *Fluate of Glucine.*

109. *Fluate of Alumine.*

110. *Fluate of Zircone.*

111. *Fluate of Silex.*

The proportions of the principles of no one of the fluates are yet known. Theſe ſalts, hitherto little examined, require an aſſiduous inveſtigation to enable us to aſcertain their component parts. They, and the ſuper-oxigenated muriates are the ſpecies that have been leaſt accurately analyzed to the preſent day.

112. *Borate of Lime.*

Proportions not yet known.

113. *Borate of Barites.*

Unknown, like the preceding.

114. *Borate of Strontian.*

Proportions unknown.

114*. *Borate of Magneſia.*

Proportions unknown.

115. *Magneſio-calcareous Borate.*

Boracic acid	66	Here is a loſs of 10.
Magneſia	13,5	
Lime - -	10,5	

116. *Borate of Pot-Aſh.*

Proportions unknown.

117. *Borate of Soda.*

Boracic acid	-	70
Soda -	-	20
Water -	-	10

8. *Super-ſaturated Borate of Soda : Borax.*

Boracic acid	-	34
Soda -	-	17
Water -	-	47

119. *Borate of Ammonia.*

Proportions unknown.

120. *Ammoniaco-magneſian Borate.*

Proportions unknown.

121. *Borate of Glucine.*

Proportions unknown.

122. *Borate of Alumine.*

Proportions unknown.

123. *Borate of Zircone.*

Proportions unknown.

124. *Borate*

124. *Borate of Silex.*

Proportions unknown.

125. *Carbonate of Barites.*

A. *Native.*	Carbonic acid	20	Kirwan.
	Barites -	78	
	Sulphate of barites	2	
	Carbonic acid	10	Fourcroy.
	Barites - -	90	
	Carbonic acid	32	Pelletier.
	Barites -	62	
	Water -	16	
B. Artificial.	Carbonic acid	7	Kirwan.
	Barites -	65	
	Water - -	28	

126. *Carbonate of Strontian.*

Carbonic acid -	30
Strontian - -	62
Water -	8

127. *Carbonate of Lime.*

Carbonic acid -	34
Lime - -	55
Water -	11

128. *Carbonate of Pot-Aſh.*

Carbonic acid	20	Bergman.
Pot-aſh	48	
Water	32	
Carbonic acid	49	Pelletier. Here is an exceſs of weight.
Pot-aſh	48	
Water	17	

129. *Carbonate of Soda.*

Carbonic acid	16
Soda	20
Water	64

130. *Carbonate of Magneſia.*

A. Saturated with acid	Carbonic acid	30	Bergman.
	Magneſia	45	
	Water	25	
B. Pulverulent magneſia of the ſhops	Carbonic acid	36	Butini.
	Magneſia	43	
	Water	21	
The ſame	Carbonic acid	48	Fourcroy.
	Magneſia	40	
	Water	12	
C. Carbonate of magneſia in regular cryſtals.	Carbonic acid	50	Fourcroy
	Magneſia	25	
	Water	25	

131. *Carbonate of Ammonia.*

Carbonic acid -	45
Ammonia -	43
Water - - -	12

132. *Ammoniaco-Magneſian Carbonate.*

Proportions not yet known.

133. *Carbonate of Glucine.*

Carbonic acid -	64
Glucine - -	25
Water - -	11

134. *Carbonate of Alumine.*

Proportions unknown.

135. *Carbonate of Zircone.*

Carbonic acid and water	44,5
Zircone - - - -	55,5

136. *Ammoniaco-Zirconian Carbonate.*

Proportions unknown.

137. *Ammoniaco-Glucinian Carbonate.*

Proportions unknown.

ARTICLE XVII.

Recapitulation of the Salts that are found foſſil, and on their Claſſification in mineralogical Methods or Syſtems.

1. THOUGH I have taken care, in the hiſtory of each ſpecies of ſalts, to note whether it were found among foſſils, and even in general, to deſcribe the principal varieties under which it appears, it will not be without its uſe, to revert again to the exiſtence of theſe ſubſtances in the ſtrata of the earth, to compare them with ſuch as have not yet been met with in thoſe ſtrata, and to point out the path purſued by mineralogiſts both for the claſſification and diſcrimination of theſe ſubſtances.

2. I ſhall firſt remind the reader, that of the 135 ſpecies of ſalts, which I have arranged and deſcribed in the preceding articles, thoſe that have beenfound in the earth, and form part of the ſtrata which compoſe it, amount at moſt to an eighth part, or thereabout. It is true I have ſuppoſed, that nature prepares a much greater number; and that, though we remain hitherto unacquainted with them, it is becauſe we have

too ſuperficially viewed, and not enough examined, ſeveral mineral ſubſtances, in which a more accurate analyſis will hereafter enable us to diſcover them. We ſhall be led to embrace this opinion, if we reflect on the ſmall quantity of minerals yet explored, and the little accurate knowledge collected reſpecting moſt of them.

3. Mineralogy, however, has gained much in this reſpect within theſe few years; and particularly ſince mineralogiſts, not content with the external characters or an examination of the phyſical properties of foſſils, have begun to add chemical experiments to their obſervations, and to inveſtigate the intrinſic nature of theſe ſubſtances. Every thing indicates, that the ſaline compounds daily created and multiplied by art, are mere imitations of ſuch as nature has formed; and that, in proportion as the ſcience of analyſis advances, we ſhall diſcover new ſpecies of foſſil ſalts, analogous to thoſe which we have hitherto only fabricated in our chemical laboratories.

4. The ancient chemiſts knew ſcarcely more than a third of the ſalts with which we are now acquainted. Many of theſe ſalts were ranked by mineralogiſts in the claſs of ſtones, on account of their inſipidity and inſolubility, or of the great quantity of water requiſite to diſſolve them. Thus the ſulphate, carbonate, and fluate of lime, under the names of gypſum, calcareous ſpar, and fluor ſpar, conſtituted a part of the ſtony ſubſtances, becauſe they were inſipid and inſoluble. The ancient method, being founded

excluſively on the ſenſible properties of foſſils, could not place theſe inſipid and inſoluble bodies by the ſide of the muriate, carbonate, and borate of ſoda, the nitrate of pot-aſh, and the triple ſulphate of alumine, the ſalt, bitter, acrid, alkaline, pungent taſte, and great ſolubility of which formed too ſtriking a contraſt to the characters of the former. Thus the claſs of ſalts was of very confined extent, compared with the other claſſes of minerals, while the very numerous varieties of the carbonate of lime alone conſtituted an entire claſs among the ſtony foſſils.

5. This method is ſtill to be found in Citizen Daubenton's ſyſtematic view of minerals. The fluor ſpar or fluate of lime, heavy ſpar or ſulphate of barites, aërated barites or carbonate of barites, phoſphate of lime, and apatite, which is but a variety of it, are ſtill placed by this naturaliſt among the earths and ſtones of the ſecond claſs, which neither ſtrike fire with ſteel nor effervefce with acids, becauſe the inſoluble ſalts in fact poſſeſs theſe properties. His third claſs is formed entirely of the carbonate of lime in the different ſtates of calcareous ſtone, calcareous earth, marble, calcareous ſpar, and concretions, conſtituting five genera; becauſe all theſe varieties of one ſubſtance, being inſoluble in water, equally poſſeſs the conſtant and unequivocal property of effervefcing with acids. Finally, he not only ſeparates from theſe ſaline ſubſtances, which are to him ſtones, the ſalts por-

properly ſo called, the foſſil ſalts, to which he aſſigns as a diſtinguiſhing characteriſtic ſolubility in water, but he makes of theſe ſalts a fourth order, ſeparated and kept at a diſtance from the calcareous ſubſtances, his third claſs of ſtones, by a fourth claſs, which compriſes the earths and ſtones that are mixtures of thoſe of the three foregoing claſſes.

6. After this removal and diſtribution of five ſpecies of ſalts into two different claſſes of ſtones, Citizen Daubenton, conſidering as ſalts only thoſe foſſil ſpecies which are ſoluble in water; divides theſe into three genera, the firſt having an alkaline, the ſecond an earthy, and the third a metallic baſe. The laſt belongs wholly, in all other methods, to the claſs of metals: and the other two preſent a deficiency, which proves it is impoſſible to make a good claſſification of theſe ſalts without having recourſe to their chemical properties; namely, the want of generic characters, which does not allow a real diſtinction to be made between them.

7. The firſt genus of Citizen Daubenton compriſes five ſpecies; 1ſt, the carbonate of ſoda, under the name of *mineral alkali*, with the two varieties of *natron* and *aphronatron*, the characters aſſigned to which are effervefcence with acids, and cryſtallization in octahedra with ſcalene triangles; 2d, the muriate of ſoda, named *common ſalt*, divided into ſea ſalt and ſal gem, diſtinguiſhed by its decrepitation in the fire,

its cubical fragments, its cryſtallization in cubes, and in hollow truncated pyramids; 3d, borax, having as varieties tincal, or crude borax, and purified borax, and as ſpecific characters a gelatinous tranſparency, ebullition in the fire, and the figure of a ſix-ſided priſm with polyhedral ſummits; 4th, ſal-ammoniac, native or factitious, volatilizing in vapour, under a granulous form, or in feathery cryſtals compoſed of tetrahedral priſms with quadrangular pyramids; 5th, nitre, or ſaltpetre, detonating on burning coals, and diſtinguiſhed into two varieties of form, one a cuneiform octahedron, the other with two commencing quadrangular pyramids.

8. The ſecond genus of this celebrated French naturaliſt, includes under the name of earthy ſalts, four ſpecies, which are *calcareous* nitre, *gypſum*, *Epſom* ſalt, and *alum*.

The nitrate of lime is characterized by its great deliqueſcence. Two varieties of figure are mentioned; one hexahedral priſms, terminated by hexagonal pyramids; the other in needles.

The ſulphate of lime, diſtinguiſhable by calcining into plaſter, and being little ſoluble in water, contains nine varieties: 1ſt, the coarſe opaque; 2d, the coarſe ſemi-tranſparent; 3d, the fine opaque; 4th, the fine ſemi-tranſparent, or *gypſous alabaſter*; 5th, the ſtriated opaque; 6th, the ſtriated ſemi-tranſparent; 7th, the decahedral ſulphate of lime; 8th, the ſame in agglutinated cryſtals; 9th, the lenticular ſulphate of lime.

The ſulphate of magneſia, eaſily diſtinguiſhed by its bitter taſte, has two varieties; one in tetrahedral priſms with dihedral ſummits, the other in tetrahedral priſms with quadrangular ſummits.

The triple ſulphate of alumine, or alum, which our author characterizes by its limpid tranſparency and glaſſy fracture, is divided into five varieties; namely, a regular octahedron, an octahedron incomplete on its edges and ſolid angles, a ſegment of an octahedron, a ſhapeleſs maſs, and feathery, or in filaments.

By adding the nine varieties of the three metallic ſulphates, which Citizen Daubenton joins with the preceding ſpecies, we have three genera, twelve ſpecies, and thirty-ſeven varieties of ſaline ſubſtances, which he admits in his mineralogical method, a much more conſiderable number than the naturaliſts before him had enumerated.

9. In the method of claſſing minerals adopted by the French ſchool of mines, and made public by Citizen Haüy, to whom we are indebted for it, ſaline ſubſtances are diſtinguiſhed from ſtones, and form a ſecond claſs, entitled, *acidiferous ſubſtances, compoſed of an acid united to an earth or an alkali.* The name of ſalts has not been employed in it, as is done, and ought to be done, in a chemical ſyſtem. This diſtribution ſhows at once, that the author has carefully

fully ſeparated the ſaline compounds from the ſtony, that he has avoided the confuſion hitherto prevalent in ſyſtems of mineralogy, and that he has felt the imperious neceſſity of no longer including in the ſame claſs ſalified or acidiferous ſubſtances, and ſubſtances which are not ſo. He informs us, that the method adopted in this ſecond claſs follows a regular courſe, becauſe it is ſubordinate to the reſults of analyſis. This is confeſſing, and with good reaſon, that there are no true diſtinctions between minerals, unleſs they be founded on the nature of foſſils. The advantage of ſuch a courſe, is not only to introduce order and connexion of ideas, but alſo giving accurate notions of the ſubſtances to be defined or made known. We ſee likewiſe, that this part of mineralogy is preciſe and complete, only becauſe the chemical analyſis of the ſubſtances on which it treats is finiſhed and exact.

10. The diviſions of this ſecond claſs of minerals exhibits three orders, founded on the nature of the baſes. It is on theſe that the French mineralogiſts have eſtabliſhed their methods, inſtead of taking their diſtinctions from the acids, becauſe the notions of the mineralogiſt are more particularly turned to the earths and alkalis, which are conſidered only as acidiferous. Accordingly, the denominations of the ſpecies begin with thoſe of the baſes, to which thoſe of the acids are added, giving them an adjective termination. In this claſs there are three orders; the firſt compriſes the earthy acidiferous

ſubſtances; the ſecond, alkaline acidiferous ſubſtances; and to the third, the alkalino-earthy acidiferous ſubſtances are referred. Here the diviſion is very irregular; for we find but one ſingle ſpecies, without a genus, in the third order, while in the two preceding both the ſpecies and genera are more or leſs numerous. The reaſon why the baſes have been taken as the heads of diviſions in this new method, turns chiefly on this, that, the mineralogiſt having to obſerve nature, his attention ought to be more particularly fixed on what ſtrikes the ſenſes, by the more fixed ſubſtance, not by that which moſt frequently eſcapes. The earths and alkalis, in fact, come under the former deſcription; the acids, under the latter. Beſides, the mineralogiſt ought to content himſelf with applying the reſults of analyſis to the obſervation and operations of nature; while the chemiſt, on the contrary, endeavours to refer the operations of nature to the reſults of analyſis.

11. The firſt order includes the earthy acidiferous ſubſtances. It is divided into four genera, determined by the four earths already found ſaturated with acid in a native ſtate; namely, lime, barites, ſtrontian, and magneſia. It may be obſerved, that we here mention only four alkaline earths; and in fact, ſilex, alumine, glucine, and zircone, have not yet been found acidiferous among foſſils. We may conſider certain clays, however, as ſulphate of alumine,

and ſome varieties of fluate of lime as ſiliciferous triple ſalts, as I have elſewhere ſhown.

12. The firſt genus, or acidiferous lime, offers five ſpecies; *carbonated lime, phoſphated lime, fluated lime, borated lime,* and *ſulphated lime.*

In the varieties of the firſt ſpecies about forty determinate forms are deſcribed; but as the number of theſe varieties appears to be immenſe, Citizen Haüy has divided this ſpecies into three ſections of determinate forms, imitative forms, indeterminate forms.

The phoſphated lime exhibits among the determinate forms the *primitive,* the *peridodecahedral,* the *annular,* the *emarginated,* and the *acroſtic.*

The fluated lime offers, of varieties for the ſame forms, the *primitive* or *octahedral,* the *cubic,* the *dodecahedral,* the *cubo-octahedral,* the *emarginated,* the *cubo-dodecahedral,* the *bordered;* among the indeterminate, the *alabeſtrite,* and *irregular;* with reſpect to colour, the *red, violet, green, blue, yellow,* and *blackiſh violet;* and with reſpect to tranſparency, the *limpid, ſemi-tranſparent,* and *opaque.*

The borated lime contains magneſia, as has been ſeen elſewhere: its form has two varieties, the *fruſtaneous,* and the *ſuperabundant.*

In the ſulphated lime Citizen Haüy purſues the ſame method for diſtinguiſhing its varieties.

13. The ſecond genus of the firſt order, occupied by acidiferous barites, affords but two ſpecies, *ſulphated barites,* and *carbonated*

barites. In the hiſtory of theſe ſpecies, I have ſhewn the principal varieties they offer among thoſe deſcribed by Citizen Haüy; and I have nothing to add here, except the general remark, that theſe two ſpecies may be known among all the acidiferous ſubſtances nature preſents to us by means of their very conſiderable ſpecific gravity, and that one may be diſtinguiſhed from the other by the latter effervescing briſkly with acids, which the former does not.

14. The third genus of the firſt order is confined to the acidiferous ſtrontian. On the firſt publication of his mineralogy, Citizen Haüy mentioned only a ſingle ſpecies of this genus, for he knew no more; namely, the *carbonated ſtrontian*, or carbonate of ſtrontian, which, approaching very near to the carbonated barites in ſpecific gravity, and equally poſſeſſing the property of effervefcing with acids, was particularly diſtinguiſhable from it by the purple flame it gave with the blow-pipe. But naturaliſts have ſince diſcovered a ſulphate of ſtrontian, which had been confounded with a ſulphate of barites, and forms a ſecond native ſpecies of this genus: ſo that ſtrontian is exactly in the ſame circumſtances as barites, with reſpect to the two different acids with which it is found combined among foſſils. The ſulphate of ſtrontian is diſtinguiſhed from that of barites, to which it approaches in form and gravity, becauſe it is penetrated by expoſure to a great

heat with a purple-red phoſphoric light, without, however, affording a phoſphorus on being calcined with charcoal, as the latter does, which by being thus treated, forms the Bolognian phoſphorus, of which I have ſpoken when giving its hiſtory.

15. The fourth genus of the ſame order compriſes the acidiferous magneſia. We find in it but one ſpecies, which Citizen Haüy mentions as unique; the *ſulphated magneſia,* or ſulphate of magneſia. In the article of this ſulphate, I have ſaid all that is known of its foſſil exiſtence and mineral varieties. To this ſpecies we muſt add that of magneſia combined with the boracic acid, though it is truly in the form of a triple ſalt with lime, as already mentioned in the firſt genus. We may be allowed to ſuſpect likewiſe, though no poſitive fact yet announces it, that magneſia exiſts combined with carbonic acid in the bowels of the earth, and that it muſt in this reſpect reſemble lime, barites, and ſtrontian, which are there found united with the ſame acid. But we ought not to be ſatisfied with conjectures concerning nature, and cannot reckon this ſpecies among natural productions, however probable may be its exiſtence.

16. In the ſecond order of this claſs of minerals, three genera are diſtinguiſhed; acidiferous pot-aſh, ſoda, and ammonia. I ſhall obſerve, that it is not poſſible to aſſign to each of theſe, generic characters independent of

their chemical properties, and capable of pointing out their difference by their phyſical, ſenſible, or external qualities: at leaſt to accompliſh this, it is neceſſary to embrace ſuch a number of qualities, that the mind is perplexed in the choice and ſelection it is obliged to make to diſtinguiſh each genus; which proves, that method here requires the light of chemiſtry for a guide, and that mineralogy is in fact a branch of this ſcience, to which it will approach ſo much the more in proportion to the progreſs it makes in the art of claſſing mineral productions.

17. The firſt genus of the ſecond order, or acidiferous pot-aſh, contains but one ſpecies, *nitrated pot-aſh*, or nitrate of pot-aſh, very diſtinguiſhable among all the ſpecies of ſalts by its detonation in the fire.

Acidiferous ſoda, or the ſecond genus, includes three ſpecies, 1ſt, *muriated ſoda*, or muriate of ſoda, characterized by its cubic form, and its ſalt taſte, and the only one of the alkaline ſalts found in the earth in maſſes, blocks, or veins; 2d, *borated ſoda*, or borate of ſoda; 3d, *carbonated ſoda*, or carbonate of ſoda. We are ſurpriſed at not finding in this genus the *ſulphated ſoda*, or ſulphate of ſoda, which ſo frequently ſhows itſelf in efflorescence on the walls of old buildings, and in ſubterranean ſtructures; but it is certain that this ſalt does not make a part of foſſils properly ſo called.

The third and laſt genus of this order, acidiferous ammonia, is confined to a ſingle ſpecies; namely, *muriated ammonia*, or the muriate of ammonia, which is extracted from the neighbourhood of Volcanos, and frequently found ſublimed in their craters. Perhaps we ſhould add to this ſpecies that of ſulphated ammonia, or ſulphate of ammonia, which many naturaliſts affirm to be likewiſe met with among the ſublimed products of ſubterranean fires.

18. As to the third order of theſe native ſaline compounds, Citizen Haüy forms it of alkalino-earthy acidiferous ſubſtances; but as it contains only alum, under the name of *alkaline ſulphated alumine*, it ſhould ſeem unneceſſary to have made an entire order for the ſake of a ſingle ſpecies, or equally requiſite to form one for the magneſio-calcareous borate, ſince this likewiſe contains two baſes united at the ſame time to the boracic acid, namely, lime and magneſia.

19. Though theſe ſeventeen or eighteen ſpecies of ſaline or acidiferous compounds do not appear either ſo numerous, or ſo difficult to be characterized and diſtinguiſhed, as to require a multitude of explanations; Citizen Haüy yet muſt add to his general claſſification, of which I have given an account, as well as to that of the firſt claſs of ſtones, tables exhibiting the comparative properties of theſe bodies, which would ſerve to render his method complete.

The following exhibits the ſyſtematic claſſification and diſtribution of theſe native ſalts.

Second Class.

Of Minerals.

Acidiferous Subſtances.

Order I.

Earthy Acidiferous Subſtances.

Genus I.

Lime.

Species I. *Carbonated Lime.*
II. *Phoſphated Lime.*
III. *Fluated Lime.*
IV. *Borated Lime.*
V. *Sulphated Lime.*

GENUS II.

Barites.

SPECIES I. *Sulphated Barites.*

II. *Carbonated Barites.*

GENUS III.

Strontian.

SPECIES I. *Sulphated Strontian.*

II. *Carbonated Strontian.*

GENUS IV.

Magneſia.

SPECIES I.

Sulphated Magneſia.

ORDER II.

Alkaline Acidiferous Subſtances.

GENUS I.

Pot-Aſh.

SPECIES I.

Nitrated Pot-Aſh.

GENUS II.

Soda.

SPECIES I. *Muriated Soda.*

II. *Borated Soda.*

III. *Carbonated Soda.*

GENUS

GENUS V.

Ammonia.

SPECIES I.

Muriated Ammonia.

ORDER III.

Alcalino-earthy acidiferous Subſtances.

SINGLE SPECIES.

Alkaline Sulphated Alumine, or Alum.

20. ON reviewing the ſmall number of ſubſtances claſſed in this table, and obſerving the methodical parade, and the diviſion into orders, genera, and ſpecies, it is not eaſy to avoid feeling, that we might have diſpenſed with ſuch a complex apparatus; as the few ſubjects it embraces, and the eaſineſs with which they may be diſtinguiſhed from each other, ſeem not to require ſuch a complication. It is perhaps ſtill more difficult to conceive, why it has been thought neceſſary to alter the che-

mical nomenclature of ſalts, and run the riſk in ſome meaſure of rendering its uſe in foreign languages problematical; when, little occaſion appearing for creating a ſyſtem of claſſification for ſuch a ſmall number of natural productions, it may be thought, that it would have been ſufficient to have borrowed from the ſyſtematical chemiſts the order already eſtabliſhed by them among ſalts, which would have rendered it unneceſſary to follow the ſeries of their baſes, for their claſſification.

Recourſe might have been had to this peculiar mineralogical arrangement, if it had been capable of furniſhing palpable, unequivocal, and conſtant external characters, ſufficiently numerous well to diſtinguiſh them. But as this end cannot be attained, it ſeems a reaſon for not ſeeking a method different from that of the chemiſts, and rendering it neceſſary to vary the names given to theſe ſaline compounds, without any ſtriking advantage.

21. In fact, nothing can be more ſimple, than to ſelect from the numerous tribe of ſalts, which we have made known, thoſe ſpecies that conſtitute a part of the foſſils, or are found among mineral productions; and to aſſign them characters eaſy to be diſtinguiſhed, which would require no chemical trials, but ſuch as the cheſt of the mineralogiſt, and the traveller always furniſh the means of making; and the following ſketch will ſhow, that it was apparently unneceſſary to have overturned the method and

nomenclature of chemiſts for this purpoſe. There are ſeven genera of ſalts, of which more or fewer ſpecies are pretty frequently met with, and have been recogniſed in the earth. Each of theſe genera, and their dependant ſpecies, may be readily diſtinguiſhed by ſome very ſtriking properties, in the following manner.

22. GENUS I.

Sulphates.

Generic characters. They emit a fetid ſmell of ſulphur and ſulphurated hidrogen gas when they are heated with charcoal by the blow-pipe.

SPECIES I.

Sulphate of Barites.

Specific characters. Inſoluble, cryſtallized, inſipid, affording Bolognian phoſphorus on being calcined with charcoal.

SPECIES II.

Sulphate of Strontian.

Specific characters. Differing from the preceding by the purple phoſphoric light it gives with the blow-pipe.

SPECIES

GENUS III.

Muriates.

Generic character. Concentrated ſulphuric acid expels their acid in a white vapour, and with its diſtinguiſhing ſmell.

SPECIES I.

Muriate of Soda.

Specific characters. Salt taſte; cryſtallization in cubes; decrepitation in the fire.

SPECIES II.

Muriate of Lime.

Specific characters. Little cryſtallizable; very deliqueſcent; very bitter, and very acrid.

SPECIES III.

Muriate of Magneſia.

Specific characters. Not cryſtallizable, deliqueſcent; precipitable by lime-water.

GENUS IV.

Phoſphates.

Generic characters. Fuſible by a ſtrong heat into enamel or glaſs; decompoſable by the acids, which ſeparate from them the phoſphoric acid.

SPECIES I.

Phoſphate of Lime.

Specific characters. Inſipid; inſoluble; yielding a beautiful flame of a yellowiſh green, when thrown in powder on burning coals.

GENUS V.

Fluates.

Generic characters. Fuſible into glaſs; giving out with concentrated ſulphuric acid a white vapour, which corrodes and takes off the poliſh of glaſs and quartz.

SPECIES I.

Fluate of Lime.

Specific characters. Cryſtallizable in cubes; having an octahedron for its primitive form; giving a blueiſh or greeniſh flame on burning coals.

GENUS VI.

Borates.

Generic character. The boracic acid is extracted from them in ſhining ſcales by the ſulphuric, nitric, muriatic, and phoſphoric acids.

SPECIES I.

Borate of Lime, and Magneſia.

Specific characters. Of a cubic figure with the angles and edges ſupplied by facets; oppoſite electricity on two oppoſite angles; hardneſs exceſſive; inſipid; inſoluble.

SPECIES II.

Borate of Soda; Borax.

Specific characters. Sapid and alkaline; ſoluble; cryſtallizable in tetrahedral or hexahedral priſms.

GENUS VII.

Carbonates.

Generic character. Making with all the weak acids diluted in water, a briſk and continued effervefcence, owing to the evolution of carbonic acid.

SPECIES I.

Carbonate of Barites.

Specific character. Not parting with its acid in the fire but by the help of the charcoal with which it is calcined.

SPECIES II.

Carbonate of Strontian.

Specific character. Differing from the preceding by the light it gives with the blowpipe.

Species III.

Carbonate of Lime.

Specific character. Yielding pure quicklime by the action of fire.

Species IV.

Carbonate of Soda.

Specific characters. Acrid taſte; ſpeedily and completely effloreſcing in the air.

Species V.

Carbonate of Alumine.

Specific character. Inſipid clay, diſſolving gradually with efferveſcence in hot acids.

Article XVIII.

Of the Salts which are found diſſolved in Natural Waters, and of the Analyſis of Mineral Waters.

1. THE ſalts which nature affords, and which are diſcovered among her productions, are not

confined to the dry, ſolid, or cryſtalline form of foſſils. The greater part of theſe may be found diſſolved in waters alſo, which frequently contain even ſuch as do not occur in the ſolid ſtate. To complete our knowledge of them, therefore, it is neceſſary to examine the nature of waters, the ſaline and foreign principles which they may contain, and which mineralize them, their claſſification founded on theſe principles, and the art of diſtinguiſhing or analyſing them, as alſo that of imitating them.

2. It is eaſy to conceive, that the waters which deſcend from the mountains, which ſwiftly ruſhes down from them in torrents, which flow in a body in rivers and ſtreams, and ſtill more thoſe which filtrate gradually into ſubterranean cavities, ſlowly traverſing the ſtrata of the earth, and, meeting with beds of clay too thick for them to penetrate, re-appear on the ſurface of the ground, where they form ſprings and brooks, muſt diſſolve in their paſſage the different ſaline matters which they traverſe, or with which they come into contact, according to their ſeveral degrees of ſolubility; that they muſt take up ſo much the more, and of ſo much the greater number of ſpecies, according to the length of ground they traverſe, and the time they remain on it; and that, according to the variety of the ſaline ſtrata they penetrate, and the ſalts they find in their way,

many reciprocal actions and decompoſitions muſt take place in them.

3. The art of diſtinguiſhing theſe different ſalts diſſolved by waters, and of eſtimating their proportion, is one of the moſt difficult taſks that can be propoſed in chemiſtry. It requires a perfect knowledge of the characteriſtic properties of all ſaline ſubſtances, and accurate ideas of their reciprocal action, that we may not admit, as has often been done, the ſimultaneous exiſtence of ſalts which deſtroy one another, and which cannot ſubſiſt together in the ſame ſolution. It requires great ſagacity and extreme dexterity in the chemiſt, as well on account of the multiplicity of the principles exiſting in theſe liquids, as of the ſmall quantity of each of thoſe diſſolved in it. Frequently, according to the remark of Bergman, the ſum of all the ſaline ſubſtances, diſſolved in a mineral water, does not exceed a ſix-thouſandth part of its weight, and yet it is found to be compoſed of ſix or eight different ſubſtances; ſo that ſome of them may probably not exceed an hundred thouſandth part of the water.

4. Though ſaline ſubſtances conſtitute the moſt frequent, the moſt abundant, and the moſt active mineralizing principles of waters, they are often accompanied with others, which muſt be diſcriminated at the ſame time, and the preſence of which renders the nature and analyſis of theſe waters ſingularly complex. We have reaſon,

therefore, to conſider this branch of chemiſtry as one of the moſt difficult, and demanding in thoſe, who make it their ſtudy, the moſt extenſive required knowledge, with the greateſt reſources of natural ſagacity. Though I muſt not pretend in this place to treat of mineral waters with all the minuteneſs that would be requiſite to give a due knowledge of the ſubject in its whole extent, yet it is of ſuch importance, and is calculated to give ſo uſeful a recapitulation of the properties of ſaline ſubſtances, that I deem it highly neceſſary to enter into ſome methodical details for its explanation. Accordingly, under ſix ſucceſſive heads, I ſhall treat, 1. of the hiſtory of the principal diſcoveries that have been made reſpecting mineral waters; 2. of the ſaline matters formed in them, with a brief ſketch of thoſe not of a ſaline nature, which are met with in them at the ſame time; 3. of the claſſification of mineral waters according to theſe ſubſtances; 4. of the re-agents by which they may be detected, and the means of employing theſe re-agents with advantage; 5. of their analyſis by evaporation; 6. of their ſyntheſis, or the artificial fabrication of mineral waters.

SECTION I.

Of the Periods of the Principal Diſcoveries relative to Mineral Waters.

5. MEN firſt diſtinguiſhed waters from one another by their taſte. Soon after, their different effects in the arts, and the occaſions of life, led to a diſcovery of their principal qualities; though to what ſubſtances theſe quaties were owing remained long unknown. Hippocrates commended light, limpid waters, void of ſmell and taſte: the hard, the brackiſh, the aluminous, and thoſe of lakes and ponds he rejected. Pliny diſtinguiſhed the nitrous, acidulous, brackiſh, and aluminous waters, and thoſe impregnated with ſulphur, iron, or bitumen. He likewiſe divided them into ſalubrious, medicinal, poiſonous, cold, warm, and hot. He reprobated thoſe which would not boil pulſe, which left a coating on the veſſels in which they were boiled, or which poſſeſſed an intoxicating property. To correct ſuch waters as were of bad quality, he adviſed them to be reduced to one half by boiling. But theſe notions, though tolerably accurate, were founded only on obſervation of the effects of waters, not on a knowledge of their principles. It is a ſtriking feature in the hiſtory of the human mind, that the ancients were totally ignorant of the art of decompoſing bodies, and entirely

deſtitute of the knowledge and inſtruments of chemiſtry.

6. Before the commencement of the ſeventeenth century we find nothing in the hiſtory of chemiſtry that has any relation to the art of analyzing waters.

In 1596, Andreas Baccius, the firſt writer who treated profeſſedly on waters, ſays not a ſingle word of experiments for decompoſing them.

Tabernæ-Montanus, or John Theodoſius, in his Enumeration of the Waters of Germany, about the ſame period, is equally ſilent in this reſpect.

In 1663, Boyle has ſpoken of ſome re-agents, and of their effects on waters, particularly with reſpect to the action of acids and alkalis on blue vegetable colours. He was acquainted with the precipitation of ſolutions of ſilver and mercury by alkalis, and the muriatic acid; and the golden colour given to ſilver by ſulphureous waters.

In 1665, Duclos undertook the analyſis of the mineral waters of France in the Academy of Sciences. He employed galls, ſulphate of iron, and litmus, as re-agents; and began to examine the reſidues of evaporated water.

In 1680, Urban Hierne publiſhed ſome Eſſays on the Waters of Sweden, which are by no means without merit. He particularly diſtinguiſhed the acidulous waters of Medvi, and brought them into uſe; and he made ſome uſeful critical remarks on re-agents, which had begun to be employed.

In 1685, Boyle gave ſome new inſtructions for diſtinguiſhing the principles of waters; propoſing the ammoniacal ſulphuret, or his *fuming liquor*, and ſolutions of nitre, ſea ſalts, muriate of ammonia, acetite of lead, nitric acid, muriatic acid, and ammonia.

7. In the beginning of the eighteenth century the analyſis of waters made freſh advances. Regis and Didier employed mallow flowers to detect acids and alkalis; Boulduc, lime-water; Burlet, alum, and litmus paper. The proceſſes of analyſis received great improvements. In 1707, Geoffroy ſubſtituted the evaporation of waters in ſhallow glaſs veſſels inſtead of their diſtillation. In 1726 and 1727, Boulduc adviſed the ſeparation of the ſubſtances depoſited or cryſtallized at different periods of the evaporation; and the precipitation of waters by alcohol, to diſtinguiſh their nature, before evaporating them. From this period to the middle of the eighteenth century, the number of re-agents ſtill continued to be increaſed; but the concluſions drawn from their effects were long uncertain and erroneous.

8. During the periods quoted, the opinions entertained reſpecting the principles of waters were very inaccurate. Paracelſus admitted among them a peculiar earth, and ſalts and metals in general. In 1699, Legivre attributed their acidulous quality to alum, the exiſtence

of which in them was denied by Duclos; who ſuſpected them to contain ſulphate of lime, which Allen firſt demonſtrated, under the name of ſelenite, in 1711. In 1682, Hierne diſcovered ſoda in them, which was called *nitre*; and this diſcovery was confirmed by Hoffman and Boulduc. In 1682, Liſter found lime in waters; Leroi, the muriate of lime in 1754; Home, calcareous nitrate, in 1756; Margraff, muriate of magneſia, in 1759; and Black made known the true nature of ſulphate of magneſia, on which Grew had written a little work in 1696, and which was already known under the name of *ſal catharticus amarus*, bitter, purging ſalt, in the waters of Epſom, Egra, Sedlitz, and Seidſchutz. The preſence of ſulphate of iron was long a ſubject of diſpute, which ſome aſſerted to exiſt in almoſt all waters, and to which others ſubſtituted a pretended ſubtile ore of iron, the ſoul of that metal, a volatile vitriol, &c.

9. At the beginning of the ſeventeenth century, gaſeous waters excited no leſs diſcuſſion among chemiſts. Hoffman admitted in them a volatile acid, eaſily diſſipated; at the ſame time he ſuppoſed them to contain alkali, which others denied, becauſe they conſidered this alkali as neceſſarily produced by fire. Henckel imagined that this alkali was derived from ſea ſalt, without being able to explain how it loſt its acid. Doctor Seip, aſcribing this acidity of waters to a ſulphureous ſpirit, which might be

obtained from them by diſtillation, explained their change in the air by the union of this with the alkali, which could take place only when the waters came into contact with it, and not in their ſubterranean conduits. In 1748, Dr. Springfield conſidered air as the cauſe of the ſolution of ſaline and earthy principles in water, which principles were precipitated in proportion to the evaporation of the air. This opinion was ſtrongly ſupported in 1755 by Venel, who found, in addition, the means of imitating acidulous waters tolerably well, by diſſolving alkaline carbonate in cloſe veſſels with the addition of an acid.

10. The diſputes relative to theſe acidulous waters were terminated, and their nature made accurately known, by Black's diſcovery of fixed air, or carbonic acid, and the ſucceſſive reſearches of Bergman, Prieſtley, Rouelle, Chaulnes, Gioanetti, Citizen Guyton, &c. who inſtructed us in the methods of diſſolving this gaſeous acid in water artificially, extracting it from water by different proceſſes, and determining its exact proportion; and taught us to conſider it as the ſolvent of chalk, or carbonate of lime, of carbonate of magneſia, and of carbonate of iron. This capital diſcovery in chemiſtry explained the reaſon why acidulous waters became turbid by expoſure to the air, or by boiling; why they depoſited ruſt of iron at their ſurface in the channels through which

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they ran; and why they formed calcareous incruſtations on bodies plunged into them.

11. Sulphureous waters, in which the exiſtence of ſulphur was proved by a crowd of facts, without chemiſts being able for a long time to diſcover the cauſe of its ſolubility, became known by the labours of Bayen, who, ſo early as 1770, publiſhed the means of ſeparating it from them; of Monnet, who ſuſpected the vapour of liver of ſulphur to exiſt in them in 1768; of Bergman, who diſcovered in them the gas of this compound, which he named *hepatic* gas, in 1774; and of Rouelle, who ſoon after confirmed the diſcovery of the celebrated chemiſt of Upſal. I myſelf gave ſome very ample details reſpecting ſulphureous waters, in my Analyſis of the Waters of Enghien, publiſhed in 1787, I ſhowed that the union of ſulphur and hidrogen was the true mineralizer of that water; and Mr. Giobert has ſince extended and confirmed that aſſertion in his well-written Treatiſe on the Water of Vaudier, printed in 1793. At preſent we have nothing to learn on the ſubject of ſulphureous waters, which are now as well known to us as the acidulous.

12. Though the knowledge and accurate analyſis of mineral waters cannot be conſidered as truly acquired till within theſe late years, ſeveral chemiſts have undertaken, at different periods, to publiſh general treatiſes, more or leſs complete, on theſe natural ſolutions of ſalts,

Wallerius,

Wallerius, in 1748, Cartheuſer, in 1758, Monnet, in 1772, Bergman, in 1778, publiſhed hydrologies, and methods of analyzing waters. There are beſides a great number of monographic works on ſome particular waters, which, on account of their merit, the great number of valuable details they exhibit, and the new data they preſent, ought to be eſteemed as certain guides in the difficult art of making a chemical examination of theſe fluids. Thoſe of Bergman on the Springs of Upſal, and the Waters of Danemarck; of Black on ſeveral Waters of Iceland; of Gioanetti on thoſe of Courmayeur; of Giobert on the Water of Vaudier; and, if I may be permitted to quote myſelf, that which I have publiſhed on the Water of Enghien, particularly come under this deſcription. Within theſe five-and-twenty years too the art of imitating mineral waters by artificial ſolutions, of different ſaline ſubſtances in pure water has been greatly improved. The diſſertations of Bergman on the recompoſition of the waters of Seidſchutz, Seltzer, Spa, and Pyrmont, and the Art of Imitating Mineral Waters by Citizen Duchanoy, phyſician at Paris, muſt be ranked in this claſs. They are the complement of the analyſis of waters, and atteſt its progreſs.

SECTION II.

Of the Saline Matters, and other Principles, which mineralize Waters.

13. THE numerous analyſes of mineral waters, made within theſe forty years, eſpecially with ſufficient exactneſs to determine their principles, have inſtructed us, that the moſt frequent and moſt abundant mineralizers of theſe waters are to be found in the claſs of ſaline ſubſtances. On this account it is more natural to treat of theſe fluids immediately after the hiſtory of ſalts, than in any other part of a methodical ſyſtem of chemiſtry. Generally ſpeaking, all that has been diſcovered concerning theſe ſaline mineralizing principles of waters informs us, that the ſalts they hold in ſolution are to be found chiefly in the claſs of thoſe that are termed foſſil. There are, however, two remarkable reflections to be made on this ſubject: the firſt, that ſuch foſſil ſalts as are little, or not at all ſoluble, do not occur in mineral waters; the ſecond, that ſuch as are moſt ſoluble, and particularly thoſe that are of the deliqueſcent kind, are never met with in the dry form, but always diſſolved. It is ſufficient to mention theſe facts in order to perceive that they are abſolutely dependent on the nature of things.

14. Among the ſulphates we find, in waters, the ſulphate of ſoda, which occurs particularly

ly in ſea-water, ſprings, and brine-ſprings; 2dly. ſulphate of lime, which exiſts chiefly in well-water, and is often the occaſion of what is called *hardneſs* in waters; 3dly, ſulphate of magneſia, which was firſt obtained from ſome mineral waters, and on this account called Epſom ſalt, Sedlitz ſalt, &c.; and which chiefly conſtitutes purging waters; 4thly, the acid ſulphate of alumine and pot-aſh, which is the moſt rare of all, though formerly imagined very common: 5thly, the ſulphates of barites and ſtrontian have not been found in waters, though they are manifeſtly depoſited in cryſtals from their native ſolutions, neither have the ſulphates of pot-aſh, ammonia, &c.

15. No chemiſt has yet announced the preſence of any ſulphite in mineral waters: it is not impoſſible, however, that ſome of theſe ſalts, particularly the ſulphites of pot-aſh, ſoda, and ammonia, may be met with hereafter in waters in the neighbourhood of volcanos, ſince theſe ſalts are frequently formed by the matters that exiſt there; but even were they diſſolved in ſuch waters, they would quickly paſs into the ſtate of ſulphates, by coming into contract with the air, and abſorbing oxigen.

16. Though ſeveral ſpecies of nitrates are very frequent on the ſurface of the earth, we rarely meet with them in mineral waters. However, we ſometimes ſeparate from theſe, nitre, or nitrate of pot-aſh, nitrate of lime, and nitrate of magneſia. Theſe ſalts exiſt

chiefly in pools, ponds, and lakes, where vegetable and animal matters are decompoſed; as likewiſe in ſome wells or reſervoirs, the waters of which run through ground impregnated with theſe ſubſtances. They are extracted in particular from the lixivia of rubbiſh worked by ſalt-petre manufacturers; and frequently two or three of them conſtitute the greater part of the principles of theſe lixivia.

17. Of all the ſalts muriates are moſt frequently and abundantly contained in mineral waters. We particularly find in them muriate of ſoda, muriates of lime and magneſia often accompanying the former, and much more ſeldom muriate of barites, which Bergman has pointed out in ſome waters. The muriates of pot-aſh, ammonia, ſtrontian, alumine, &c. have not been diſcovered in them. There is a conſiderable number of waters, the nature and principal character of which are determined by the preſence of muriate of ſoda, and the large quantity of it which they contain.

18. Neither phoſphates not fluates have yet been found diſſolved in mineral waters. The earthy phoſphates, and particularly the phoſphate of lime, the only one met with among foſſils, are in fact inſoluble: beſides, they are not very common. It cannot be doubted, however, that theſe ſalts, depoſited in ſparry laminæ, or in regular and tranſparent cryſtals, conſtituting apatite and chryſolite, have been

diſſolved in water, and ſlowly ſeparated from the ſolution. As to the ſoluble alkaline phoſphates, ſince they never exiſt in mineral ſtrata, we cannot expect to find them in waters. Of the fluates the only one known in a foſſil ſtate, the fluate of lime, though evidently depoſited from water, has never yet been found diſſolved in mineral waters.

19. The ſame may be ſaid of the borates. Borax, or the ſuperſaturated borate of ſoda, which appears to exiſt native in ſome of the waters of Perſia, India, China, and Japan, has notwithſtanding never yet been detected among the mineralizing principles of waters. The magneſio-calcareous borates, ſhows by its ſituation, its cryſtallization, and its perfect or ſemitranſparency, that it owes its formation to water; yet in the waters in the vicinity of Lunenburg, the only place where the borate called *cubic quartz* exiſts, nothing has been found that indicates its preſence, or gives any light concerning its cryſtallization and depoſition.

20. The carbonates on the contrary are the moſt frequent, and often the moſt abundant of the ſalts that mineralize waters; as they are of thoſe that are found in a ſolid form among the ſtrata of foſſils. It ſeems as if theſe compounds were thoſe that coſt nature leaſt pains, and were fabricated by her with the greateſt profuſion. Though the carbonates of lime and magneſia are nearly inſoluble, nothing is ſo common as to find theſe two ſalts among the

mineralizing principles of waters. Indeed it muſt be confeſſed they are diſſolved in them by means of the carbonic acid, which is diſſipated by heat, or by contact with the air, and lets fall the two ſalts as it flies off in vapour. The carbonate of ſoda is met with in ſeveral waters, which have even been called alkaline on account of its preſence. It is very common for ſuch waters to be at the ſame time acidulous, or loaded with carbonic acid. Sometimes, but more rarely, the carbonate of ammonia is found in ſmall quantity in certain waters, as thoſe of pools or marſhes, where organic ſubſtances remain and putrefy.

21. I have pointed out the principal ſpecies of ſalts, that have been detected in mineral waters. It is almoſt ſuperfluous to ſay, that it is rare to find any containing only one ſpecies of ſalt; that the number of thoſe exiſting together in them is never conſiderable, and very ſeldom exceeds four or five; and that there are ſome which mutually exclude each other, as ſulphate of ſoda or magneſia, and the nitrate or muriate of lime, the calcareous ſalts, and carbonate of ſoda.

22. To the different ſaline ſubſtances which I have enumerated nature frequently adds other matters, belonging either to the claſs of burning bodies or ſimple combuſtibles, to that of acids, to that of metals, or to that of vegetables. Caloric, oxigen gas, atmoſpheric air, ſulphurated hidrogen gas, and even an

earthy

earthy or alkaline ſulphuret, conſtitute the firſt. Oxigen gas, or atmoſpheric air, cannot be found in them together with ſulphurated hidrogen gas. It is not true, as was ſome time thought, that metals, as ſuch, in their ſtate of purity, can ever be found in waters. Atmoſpheric air renders waters light and briſk in their taſte and properties for domeſtic uſe. Sulphurated hidrogen gas forms the greater part of ſulphureous waters.

23. Of the acids none have yet been found pure diſſolved in native waters, but the carbonic and boracic. The firſt is much more common and abundant than the ſecond: it is found united with many different and various ſalts, and by it many of theſe are rendered very ſoluble. The boracic acid, which has yet been diſcovered only in certain waters of the lakes in Tuſcany, is there united with but few different ſaline ſuſtances, and never conſtitutes mineral waters properly ſo called. No other acid has ever appeared uncombined in waters.

24. Of the earthy baſes only ſilex and alumine have yet been obtained from waters. The firſt of theſe particularly, according to the experiments of Bergman and Black, appears to be contained in them in a proportion much greater than could ever have been imagined, or than the art of chemical ſolution by ſimple water could ever have enabled us to conceive. It is owing to this, that we ſee waters depoſiting it by the contact of air, and by ſponta-

neous evaporation, as thoſe of the fountain of Geyſer in Iceland; and hence we ought not to be ſurprized at finding ſilex conveyed into vegetables and animals, and forming concretions in them.

Alumine, which has been admitted as the cauſe of the ſoapy quality in waters, is ſeldom more than ſuſpended in them, and gives them that turbid and milky appearance, by which they are eaſily diſtinguiſhed.

Lime has been announced in ſome waters in the neighbourhood of volcanos; but the aſſertion has not yet been confirmed by any accurate experiment. Beſides, it cannot be applied to mineral waters properly ſo called, ſince no one of thoſe ranked in this claſs has ever afforded any thing of the kind.

No perſon has ever met with any alcali, potaſh or ſoda, barites or ſtrontian, pure and unmixed in waters: and it is even eaſy to conceive, that this cannot be, on account of the powerful affinity which theſe ſubſtances poſſeſs for a number of bodies.

25. The mineralizing principles of waters, excluſive of ſalts, are not confined to the matters treated in the three preceding claſſes of ſaline ſubſtances. We find among them ſeveral metallic ſalts likewiſe, that is to ſay, combinations of oxides of metals with acids; and ſome of the matters that have belonged to vegetable compounds. It is more eſpecially iron, that gives riſe to the firſt of theſe mineralizing

principles of waters, which we find in them moſt commonly united with carbonic acid, and ſometimes, but much more ſeldom, with the ſulphuric, or muriatic. Copper is found in them much more rarely in the ſtate of ſulphate, and forms thoſe poiſonous waters, which exiſt only in mines of this metal. The preſence of oxide, of arſenic too has even been announced in ſome ſubterraneous waters, running among ſtrata of ores impregnated with this dangerous metal.

26. Laſtly, colouring vegetable matters, or extracts of plants, and bitumens, have been reckoned among the ingredients of waters. Theſe extracts are found only in waters, where leaves, ſtalks, barks, and even entire aquatic plants, lie and putrify; and theſe are not mineral waters properly ſo called.

It is by no means uncommon, as will hereafter appear, for liquid bitumens to exude through ſubterranean waters, and float on their ſurface, where they are collected: and it is not more unuſual for ſubterranean waters to paſs through veins of ſolid bitumen. It is obvious, that the fluid muſt he more or leſs impregnated with bitumen, in either of theſe caſes. We do not ordinarily reckon theſe, however, among medicinal waters, or mineral waters properly ſo called: and what in the latter was once termed the bitumen of waters, a product of evaporation, of an acrid, bitter, ſtrong taſte, was a deliqueſcent ſalt, almoſt always muriate of lime.

SECTION III.

Of the Claſſification of Mineral Waters according to their Principles.

27. THOUGH among the foſſil productions that mineralize waters we reckon more ſaline ſubſtances than matters of a different nature, it is nevertheleſs neceſſary to have regard to both in claſſing and dividing theſe natural fluids. A claſſification of waters is one of the moſt uſeful and important objects, that can be treated of in natural philoſophy. It enlightens all the ſciences, and all the arts reſpecting the employment of ſuch or ſuch a water: for it ought not to compriſe merely the waters uſed in phyſic under the name of medicinal, but likewiſe all thoſe, which, containing too ſmall a number of principles, or principles not ſufficiently potent, to have a ſpeedy and determinate or uſeful action on the animal economy, yet contain enough to produce ſome effects, not altogether indifferent in domeſtic uſes, or the proceſſes of art.

28. In this point of view, it will be uſeful to divide all native waters into two great claſſes; the firſt compriſing waters conſidered with reſpect to the places they occupy, the

bulk they preſent, and the manner in which they are placed on the ſurface of the globe, This claſs includes all waters uſed for domeſtic purpoſes or in the arts. To the ſecond belong the leſs abundant waters, confined in ſome degree to certain particular ſpots of the globe, and diſtinguiſhed by much more ſtriking effects on the animal economy. Theſe are the *medicinal waters.*

29. In the firſt, or *economical* claſs, are ranked ſnow, rain, ſpring, river, well, lake, marſh, and ſea-water.

Snow-water, according to Bergman, contains a little muriate of lime, and ſome ſlight traces of calcareous nitrate. When freſh melted it is diſtitute of air, and of carbonic acid, which are found in all the others; and to this probably are owing its diſagreeable effects on animals.

Rain-water contains the two ſalts of the preceding in larger proportions. It is, beſides, ſufficiently impregnated with air, and with a little carbonic acid, which render it very uſeful to vegetation. The ancient chemiſts ranked it with diſtilled water: but it is evident that it is leſs pure, and it frequently contains four ſubſtances not found in water that has been diſtilled. When rain-water is collected for chemical purpoſes, the laſt that falls ſhould be taken.

Spring-water is very pure when it runs over ſand. In other caſes, it moſt frequently contains carbonate of lime, calcareous muriate, muriate of ſoda, or carbonate of ſoda.

River-water is frequently more pure than that of ſprings; its motion purifying it. The ſame principles are found in it; but frequently leſs abundant than in the preceding.

Well-water, almoſt always remaining in ſaline ſoils, contains, beſides the ſalts juſt mentioned, ſulphate of lime and nitrate of pot-aſh; ſo that there are almoſt always five or ſix ſalts in it at a time, and it is not eaſy to make an accurate analyſis of it, when we would carry it ſo far as to aſcertain their proportions.

The water of *lakes* is leſs limpid and more heavy than the preceding. It frequently forms a ſpontaneous depoſition of earthy ſalts: and is often coloured, and of a diſagreeable taſte. Beſides the five or ſix ſalts already mentioned, it almoſt always contains extractive matter.

Marſh-water, more ſtagnant than any of the foregoing, is ſtill leſs briſk, leſs limpid, more foul, and impregnated with ſtill more of extractive matter, ſo that it often has a yellowiſh colour.

Laſtly, *ſea-water*, rendered ſalt as all the world knows, by the muriate of ſoda, which nature has placed in it, alſo contains ſulphate of magneſia, ſulphate of lime, and much extractive matter.

30. Mineral waters properly ſo called, or rather medicinal waters, ought to be claſſed according to the principle that predominates

in them. Conſidered in this point of view, they may be divided into four claſſes, namely, acidulous waters, ſaline waters, ſulphureous waters, and chalybeate waters. Though the ſecond only ſhould ſeem to require to be treated of here, as it is from the properties of ſalts we have been led to their hiſtory, it may not be altogether uſeleſs to ſay a few words likewiſe of thoſe, which, though of another nature, frequently contain ſome ſalts.

CLASS THE FIRST.

Acidulous Waters.

THESE are waters in which carbonic acid predominates. They are characterized by their poignancy, agitation, bubbles, the red colour they give to litmus, and the precipitate they form in ſolutions of barites, ſtrontian, and lime. None of them contain carbonic acid pure and ſimply: almoſt all of them at the ſame time hold in ſolution muriate of ſoda, carbonate of ſoda, carbonate of lime, carbonate of magneſia, and often theſe four ſalts at once, as Seltzer water. There are ſome, too, in which iron is found. Laſtly, ſome are warm, or thermal, at the ſame time that they are acidulous, as thoſe of Vichy, Mont-d'Or, Châtel-Guyon, &c.; and others are cold and alkaline, as thoſe of Myon, Bard, Langeac, Chateldon, Vals, &c.

CLASS THE SECOND.

Saline Waters.

THIS name I appropriate to thoſe of which the predominant principles are ſalts properly ſo called, and which in conſequence belong more immediately to this ſection than any of the others. They may at the ſame time contain other matters, carbonic acid, ſulphurated hidrogen gas, or iron: but theſe are in too ſmall quantity, compared with the former, to be conſidered as equal objects of attention.

This ſecond claſs may be divided into five orders, according to the ſpecies of ſalt which is predominant in the waters. If they be loaded with ſulphate of lime, they conſtitute *hard waters*, not pleaſant to the taſte, incapable of diſſolving ſoap, and unfit for boiling pulſe, ſuch as the well waters of Paris.

When they contain ſulphate of magneſia predominating over their other principles, they are *bitter* and *purgative*, as the waters of Sedlitz, Seidſchutz, Egra.

If it be muriate of ſoda which they contain in exceſs, they are *ſalt*.

Carbonate of ſoda, when more copious than the other ſalts, forms *alkaline waters*.

Laſtly, when they hold abundance of carbonate of lime; which is never diſſolved in them without the exiſtence of carbonic acid, but may be preſent without an exceſs of it, and ſo that the calcareous ſalt alone characterizes them; they form an *earthy* kind of *hard waters*, which more or leſs eaſily depoſit their inſipid ſalt in ſtalactites, or incruſtations.

CLASS THE THIRD.

Sulphureous Waters.

THESE are clearly characterized, and eaſy to be diſtinguiſhed by their fetid ſmell, their property of gilding and blackening ſilver, and their depoſiting ſulphur when coming into contact with the air. They appear to form two orders: thoſe which are impregnated only with ſulphurated hidrogen, without an earthy or alkaline baſe, as are the majority of ſulphureous waters; and thoſe which contain a true ſulphur, as the waters of Bareges, Cauterets, les Eaux-Bonnes, &c. apparently do. Moſt of theſe waters, beſides their ſulphureous principle, contain ſalts, particularly alkaline and earthy muriates and ſulphates.

CLASS THE FOURTH.

Chalybeate Waters.

IT will be ſeen in the following ſection, that iron is ſo abundant in the bowels of the earth, and ſo frequently diffuſed through its ſtrata, that it becomes one of the moſt uſual mineralizing principles of waters, and that of all mineral waters, the chalybeate are the moſt common. There is ſcarcely a country in which one or more of theſe ſprings will not be found. In theſe waters three orders ſhould be diſtinguiſhed according to the ſtate of the iron contained in them. Either this metal is diſſolved in them in the ſtate of carbonate by the carbonic acid, but ſo that the latter is not in exceſs; and in this caſe they are ſimple chalybeate waters, as thoſe of Forges, Aumale, and Condé: or the ſame carbonate of iron, diſſolved by its acid, is accompanied by a great exceſs of the latter; and then they are acidulous chalybeate waters, as thoſe of Spa, Pyrmont, Pougues, Buſſang, &c.; or laſtly, the iron is contained in them in the ſtate of ſulphate, as it appears to be in thoſe of Paſſy, Provins, &c.

31. To theſe four claſſes, compriſing ten orders of mineral waters properly ſo called, or ſufficiently impregnated with ſalts and foſſil ſubſtances to poſſeſs medicinal properties, ſome authors further add, 1ſt, *ſimple thermal* waters, or waters naturally hot, without containing any principle beſide caloric; 2dly, *ſaponaceous waters*, which are ſaid to contain argil or alumine, by which they are rendered ſoft and unctuous, but the nature and exiſtence of which have not been eſtabliſhed by experiments ſufficiently deciſive; 3dly, *bituminous waters*, the compoſition of which is not more accurately confirmed than that of the preceding, and which, beſides, are not included among waters

34. From what has already been ſaid of re-agents in general, it may be conceived, that all chemical ſubſtances, whatever be their nature, provided their properties and compoſition be well known, may ſerve as re-agents, and that, even no compound is uſeleſs to an able and induſtrious chemiſt in his analyſis. But by long ſearch, we have learned to make a choice of ſome leading ſubſtances, the effects of which being compared are ſufficient to point out the different principles that exiſt in waters. In treating of mineral waters in particular therefore, it is neceſſary to point out thoſe re-agents, by the help of which we are accuſtomed to examine them. They are in general of two claſſes: they either belong to the genera of ſubſtances already noticed in the preceding ſections; or are taken from different ſections, either from among the ſolutions of metals, or from matters which conſtitute the bodies of vegetables and animals, or which are obtained from them.

36. Two circumſtances that complicate or vary the effects of re-agents, muſt render their uſe more difficult, and require great circumſpection on the part of chemiſts. One is, that the ſame ſubſtance uſed as a re-agent, ſometimes produces a ſimilar apparent effect on two, three, or more different matters contained in waters: the other, that one re-agent may produce ſeveral of thoſe effects in the ſame water. Both theſe inconveniences, however, are remedied, by

employing and comparing the effects of ſeveral of theſe re-agents, and examining the precipitate formed by them. This method of proceeding, the only one that can render the uſe of re-agents much more certain and advantageous, ſuppoſes that we do not preciſely fix their number, which ought to have no limits but the induſtry or knowledge of the chemiſt; and that we do not content ourſelves with adding a few drops to a ſmall quantity of water, but that we treat this water with re-agents in the large way, if it be neceſſary, ſo as to obtain a quantity of precipitate ſufficient for an accurate analyſis.

36. The re-agents taken from the claſſes of ſubſtances already examined, belong either to burned bodies and acids, to alkaline or earthy baſes, or to ſalts. Among the acids, thoſe which are moſt frequently and moſt ſucceſsfully employed for examining waters, are the ſulphuric, the ſulphureous, the nitrous, and the oxigenated muriatic.

The firſt announces the preſence of barites in waters by the heavy and copious precipitate it forms; and that of carbonic acid, or of earthy or alkaline carbonates, by the effervеſcence it produces.

The ſulphureous acid ſhows ſulphur as a white precipitate remaining a long time ſuſpended in waters, which contain it in the ſtate of ſulphurated hidrogen.

The nitrous produces the ſame effect, and deſtroys the fetid ſmell of theſe waters, ſeparating the ſulphur in a white powder, which collects into ſmall globules, on being expoſed to the action of heat.

The oxigenated muriatic acid ſerves for the ſame purpoſe by decompoſing the ſulphurated hidrogen. It frequently happens, that this acid burns the ſulphur at the ſame time with the hidrogen, when it is employed in too large a quantity.

37. The earthy or alkaline baſes moſt employed as re-agents are three in number: lime, pot-aſh, and ammonia, all in a ſtate of ſolution. Lime-water abſorbs carbonic acid, and precipitates with it in chalk, the weight of which indicates that of the acid: it likewiſe decompoſes the carbonate of ſoda it meets with, precipitating carbonate of lime: laſtly, it takes the acids from magneſia, which it precipitates in little whitiſh clouds, that ſlowly condenſe. This triple effect, which may take place at the ſame time, would then require an examination of the precipitate formed: the proportions of the carbonate of lime and of the magneſia, and the examination of the liquor, would aſcertain the relations and co-exiſtence of each effect; but with too much difficulty for lime-water to be truly uſeful, except in one of the caſes mentioned, particularly for appreciating the quantity of carbonic acid contained in the mineral water. To diſtinguiſh the acid belonging to the carbonate of ſoda from what was free in the water, an equal quantity of the liquid muſt be precipitated, after it has been

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deprived of the free acid by long boiling, and the weight then obtained muſt be ſubtracted from the ſum total of that before produced in the water unboiled.

38. Pure liquid pot-aſh produces ſeveral ſimultaneous effects in waters. It decompoſes the ſulphates, nitrates, and muriates of lime and magneſia, and ſeparates their earths at the ſame time: it precipitates the carbonates of lime and magneſia, diſſolved by means of the carbonic acid, which it abſorbs: when it is thoroughly concentrated, it even renders turbid, waters containing alkaline ſalts, becauſe it diminiſhes their ſolubility by the attraction it exerts on the water. This laſt effect is aſcertained by adding more water, as this re-diſſolves the precipitate, which was, beſides, in ſmall cryſtals. The calcareous and magneſian earths diſſolve in acids without efferveſcence: the earthy carbonates, ſeparated by the abſorption of the carbonic acid, unite with it on the contrary, with a briſk efferveſcence. The metallic ſalts are likewiſe decompoſed and precipitated by pot-aſh: but the colour, form, and whole appearance of the oxides, particularly of that of iron, when once ſeparated, render them eaſily known.

39. Ammonia decompoſes only the magneſian and aluminous ſalts that may occur in waters: it likewiſe precipitates the former only in part, producing triple ſalts with the portion which remains undecompoſed. It ſeparates alſo the carbonates of lime and of magneſia

that are diſſolved by the carbonic acid, this acid being abſorbed by it. It does the ſame with the carbonate of iron, when in like manner diſſolved by this acid: but it acts particularly on cupreous ſalts, and eſpecially on the ſulphate of copper, which is found in ſome waters. Theſe cupreous ſolutions are made by it to aſſume a blue colour, which very readily detects their nature, and the preſence of the metal by which they are mineralized. This volatile alkali is ſcarcely ever uſed as a re-agent, becauſe its effects are not very ſenſible, becauſe it is leſs uſeful than lime-water, and becauſe the precipitate it gives, unleſs it be a metallic oxide, is difficult to determine, though it is almoſt always incomplete, and yet mixed with ſeveral different ſubſtances.

40. In the ſection of ſalts there are only the earthy muriates, and alkaline carbonates, which can have any advantage as re-agents. The muriate of barites ſerves to detect ſulphates, and even the quantity of ſulphuric acid contained in a water, from the weight of the ſulphate of barites obtained. The muriate of lime precipitates alkaline ſulphates in a calcareous ſulphate. The alkaline carbonates, which were formerly employed as alkalis, to detect and precipitate earthy ſalts, at a time when only thoſe with baſes of abſorbent earth were known, do nothing more than aſcertain their preſence in general, by precipitating together thoſe with baſes of barites, ſtrontian, lime, magneſia, and alumine. It is very difficult to know exactly the effects, often

numerous, which they produce, unleſs we particularly examine the precipitates they form.

I have ſaid, that the re-agents not included among the ſubſtances treated of hitherto, belong either to the ſolutions of metals, or organic compounds.

41. As to the metallic ſalts there are two in particular, nitrate of mercury and nitrate of ſilver, which are univerſally employed for analyzing waters, and which offer accurate information of their nature. Both unequivocally announce the preſence of ſulphuric acid, and of muriatic acid, without indicating the baſes however, to which theſe acids are united. In the hiſtory of the two metals, with which theſe ſolutions are prepared, what will be ſaid of their nitrates will render our knowledge of the action of theſe metallic ſalts or waters much more preciſe, much more complete, and conſequently much more clear. It will be ſeen likewiſe, in the following ſections, that a great number of other metallic ſalts may be employed by chemiſts for attaining a knowledge of the principles of mineral waters.

42. Vegetables afford, for the analyſis of waters, three or four very uſeful colouring matters, two acids, and a metallic ſalt, the action of which is very advantageous in this kind of analyſis. Litmus, which is reddened by the hidroſulphuret and the carbonic acid of waters, and which in the latter caſe loſes its redneſs by expoſure to the air, which takes from it the carbonic acid; the tincture of violets, which is

turned green by the carbonates of ſoda and lime, as well as by the ſalts of iron; paper ſtained yellow by turmeric, which alkaline ſubſtances, and even the light and earthy, change to a violet purple; and the faint blueiſh or reddiſh tinge of mallows, which is rendered a fine green by the ſame ſubſtances, are four re-agents uſed with ſucceſs for diſcovering the preſence of the ſubſtances here enumerated.

The oxalic acid, either natural, extracted from the ſalt of wood-ſorrel, or artificially prepared as will be ſhown, with ſugar and nitric acid, announces with certainty, lime, which it takes from all other acids, and with which it forms an inſoluble ſalt, the precipitate of which is perceptible when it is uſed in the ſmalleſt quantity.

Gallic acid indicates in waters the preſence of iron, by the colour of red wine, or the black inky precipitate which it occaſions. If it produce neither of theſe effects, we may be certain the water contains no iron.

The acetite of lead is blackened by hidroſulphuret, precipitated in ſmall white inſoluble grains by all the ſulphates, and in a heavy white powder, ſoluble in vinegar, by all the muriates. Alkaline or earthy carbonates in waters, likewiſe precipitate the acetite of lead.

Alcohol and vinegar are often uſeful in the analyſis of waters, but rather as ſolvents of ſome of their principles, as will appear below, than as re-agents.

43. Animal ſubſtances were formerly much employed for analyzing waters. Blood, milk, bile, were mixed with them, and from their action on theſe fluids, the effects they would produce on living animals were inferred. But theſe ridiculous inferences have long been rejected as dangerous errors. At preſent nothing of this kind is employed for the analyſis of waters but a chemical compound, made of animal ſubſtances, treated with two of the fixed alkalis. This compound, the deſcription of which cannot be given with propriety in this place, is named pruſſiate of pot-aſh, or of ſoda, becauſe, when it meets with iron in any water, it lays hold of it, and precipitates it in a fine blue colour, called Pruſſian blue. Particular mention will be made of it in the eighth ſection of this work.

SECTION V.

Of the Analyſis of Waters by Evaporation.

44. WHATEVER care we take in the employment of re-agents, they are not ſufficient to ſhow with accuracy the number and proportions of the ſalts, or other matters contained in mineral waters: they give us only preliminary ideas, calculated to guide us in the other proceſſes, which ſhould afterwards be adopted. Thoſe to which we have recourſe for completing the analyſis of a water, require the employment of fire, or evaporation. In expoſing mineral waters to heat, we have two objects in view: the one, to collect the volatile matters that may exiſt in

them, the other, to obtain ſeparately and in a ſolid form, the fixed and ſaline ſubſtances, which conſtitute their mineralizing principles.

45. To ſeparate the gaſes, the carbonic acid, ſulphurated hidrogen gas, or atmoſpheric air, which may be diſſolved, one or other of them in a water, it is diſtilled in a retort in the quantity of a few pints or pounds, a jar filled with mercury being adapted to the neck of the retort. The water is boiled a few minutes, till nothing more is extricated from it: the quantity of air which was contained over the water in the retort, is ſubtracted from the gas obtained: the increaſe or diminution of the preſſure on the gas collected in the jar is taken into account, in order to calculate its quantity with preciſion; and it is examined by the known proceſſes. To this diſtillation, however, which never gives the exact quantity of the gas, I prefer its abſorption or deſtruction by re-agents, as lime-water for carbonic acid, oxide of lead or nitrous acid for ſulphurated hidrogen gas, and ſulphate of iron for atmoſpheric air.

46. The evaporation intended to collect the ſalts or fixed matters, ſhould be employed on fifteen or twenty pounds, at leaſt of waters the moſt loaded with principles, and on three or four times as much for waters that contain little. It ſhould be conducted in veſſels of ſilver, earth, or porcelain, with a moderate heat, and excluding duſt by means of a lid pierced with holes, or a piece of gauze doubled. Formerly, the evaporation was performed at ſeveral times, and the

various ſubſtances were ſeparated at the different times at which they made their appearance. At preſent we have found, that this ſeparation is neither accurate nor advantageous; and it is admitted to be much better, to evaporate waters to dryneſs ſo as to obtain the reſiduum entire. Great care is taken to moderate the heat toward the end of the evaporation: the matter that is left is moderately dried, weighed with care, and reſerved to be treated in the following manner.

47. Experience having ſhown, that this reſiduum of the evaporation of mineral waters was compoſed of deliqueſcent ſalts, of ſalts ſimply ſoluble in cold water, of other ſalts ſoluble in a large quantity of boiling water, and laſtly of matters inſoluble in water at any temperature: the art of analyzing the reſiduum has been founded on this knowledge.

It is treated firſt with five or ſix times its weight of highly rectified alcohol, which is ſlightly heated, and left to ſtand on it ſome hours. This menſtruum being poured off, the reſiduum is found to have loſt its deliqueſcent property.

In the ſecond place it is lixiviated with eight or ten times its weight of cold water, which diſſolves the alkaline ſalts.

The reſiduum left by theſe two ſolvents, is boiled in three or four hundred times its weight of water, which takes up the leaſt ſoluble ſalts.

Laſtly, as a final analyſis, acids of different ſtrengths are ſucceſſively employed, the weakeſt firſt, to ſeparate and diſcover the inſoluble earthy ſalts, metallic oxide, and ſilex, which frequently remain mixed after the action of the other three menſtrua. Each of theſe lixivia is then examined ſeparately.

48. The alcohol ſolution moſt frequently contains muriates of lime and magneſia, and but rarely nitrates of the ſame baſes, all which ſalts are deliqueſcent, and ſoluble in alcohol. Theſe are detected, and their proportions determined, by evaporating the ſolution to dryneſs; re-diſſolving the ſalts in water, after having weighed them with accuracy, and precipitating the magneſia by lime, and the lime by ſulphuric or oxalic acid. To obtain an accurate reſult, the aqueous ſolution may be ſeparated into three equal parts, and one of them decompoſed by lime-water, which will give the quantity of magneſia by tripleing the weight of what is obtained; a ſecond precipitated by the oxalic acid, and the third by the ſulphuric: on comparing the quantities of theſe two precipitates, and calcining the oxalate, which will leave only pure lime, the exact weight of the lime will be found. The acid united to theſe baſes may be aſcertained by pouring a little concentrated ſulphuric acid on a ſmall portion of the reſiduum obtained by evaporating the alcohol. The vapour, diſengaged, will eaſily diſtinguiſh whether it be the muriatic acid or the nitric.

49. The lixivium, in cold water, contains very ſoluble ſalts; muriate of ſoda, ſulphate of ſoda, ſulphate of magneſia, nitrate of pot-aſh, or carbonate of ſoda, never all of them at once,

but ſometimes two or three together. It muſt be obſerved, however, that a little muriate of ſoda, or nitrate of pot-aſh, will have been diſſolved in the alcohol with the deliqueſcent ſalts, but that this ſmall portion may be ſeparated and obtained by evaporation. The ſalts diſſolved in this aqueous lixivium, are diſcovered and ſeparated by cautious evaporation: they are obtained ſucceſſively one after another, and are diſtinguiſhed by their figure, taſte, and other properties.

50. In the lixivium made with boiling water there is never any thing but ſulphate of lime, which is detected, and its quantity at the ſame time determined by oxalic acid, which precipitates the lime, and by a ſolution of barites, which takes from it the ſulphuric acid. It may be obtained likewiſe by evaporation in the form of little ſcales, inſipid and inſoluble, which, being heated with charcoal, afford a ſulphuret of lime, of a reddiſh colour, and emitting a fetid ſmell the inſtant it is thrown into water.

51. The reſiduum of the mineral waters treated by the three preceding menſtrua, contains earthy carbonates, with or without carbonate of iron, and often mingled with alumine and ſilex. The preſence of iron may be known by a yellow or reddiſh colour. In this caſe the reſiduum is to be wetted, and expoſed to the ſun and air for ſome days, in order to oxidate the iron, and render it inſoluble in acetous acid, which is firſt to be employed for diſſolving the earthy carbonates. This firſt

ſolution, which commonly forms acetites of lime and magneſia, is to be evaporated to dryneſs; and on leaving the ſalt thus obtained in a ſtate of expoſure to the air, the magneſian acetite will abſorb its humidity, and may be ſeparated from the calcareous acetite by means of this deliqueſcence. They may likewiſe be ſubjected to all the modes of trial neceſſary to aſcertain their proportions.

The iron and alumine being afterward diſſolved by the muriatic acid, they are to be ſeparated, and their reſpective quantities aſcertained, by the appropriate methods. Nothing then will remain but the ſilex, to put the exiſtence of which beyond a doubt, it is to be treated with carbonate of ſoda by the blowpipe, when it will fuſe with efferveſcence into a tranſparent vitreous globule.

SECTION VI.

Of the Syntheſis, or Artificial Fabrication of Mineral Waters.

52. A CHEMICAL analyſis has long been conſidered as well executed, when by the aid of ſyntheſis we can re-compoſe the matter analyzed. This truth is applicable to mineral waters, though the ſyntheſis of theſe is to be claſſed among the number of things that have been diſcovered within a few years. In fact, we ſhould not depend on the accuracy of an analyſis of a water till we have made an exact imitation of it by diſſolving in the pure fluid

the ſame principles as we had diſcovered, and in the ſame proportions, ſo that this imitation ſhall exhibit the ſame appearances on every trial, and with every re-agent, as the natural water.

53. Since the diſcoveries of the carbonic acid, and the great variety of ſaline ſubſtances, we have ſucceeded ſo well in making accurate analyſes of mineral waters, and conſequently in re-compoſing them, that it has given birth to a new art of no ſmall importance to mankind, as it is employed in the preparation of medicaments appropriated to a conſiderable number of diſeaſes. For this purpoſe the firſt thing to be done is to chooſe very pure ſpring or river water, which contains little or no foreign matter: in this, carbonic acid is to be diſſolved, if for an acidulous water, and then the ſalts which analyſis has ſhown the water we would imitate to contain. If it be a chalybeate water we would fabricate, iron is to be added.

54. When we would prepare ſulphureous waters, we ſaturate water well boiled and deprived of its air, with ſulphurated hidrogen gas, diſengaged from alkaline ſulphuret, or ſulphuret of iron, on which, previouſly reduced to powder, is to be poured ſulphuric or muriatic acid diluted in water. When this water is ſo ſaturated by means of gentle agitation, the ſalts or fixed matters we know to be contained in it are to be introduced. In this imitation we do not employ the inert ſubſtances, as the carbonate and

ſulphate of lime, which are found in the natural water we would imitate; we admit only the active ſapid ſalts, which are taken in a pure and cryſtallized ſtate. We may even employ them in greater quantity than the natural water contains, and thus prepare waters of greater ſtrength, and more penetrating, than thoſe we would imitate.

55. Bergman has given the means of thus imitating the waters of Seidſchutz, Seltzer, Spa, Pyrmont, St. Charles in Bohemia, and Aix-la-Chapelle. The following are the principles, which, conformably to his analyſis, he propoſes to be diſſolved, to imitate each of theſe mineral waters, moſt of which, in fact, are in high repute. In this table I ſhall firſt give the quantity of the principles in grains, proportioned thus by Bergman to a quantity of water alſo eſtimated in grains, and then their proportions in decimal fractions, or in thouſandth parts of the water containing them.

BIBLIOTHECA BODLEIANA

SEIDSCHUTZ WATER.

Weight - - - - -	= 17991 $\frac{17}{32}$ grains	= 1000
Specific gravity - -	= 1,0060	
Pure air - - - - - -	= $\frac{43}{108}$ cubic inches	= 0,011
Carbonic acid - . -	= $\frac{45}{103}$ cubic inches	= 0,015
Carbonate of lime - -	= 1 $\frac{19}{21}$ grains -	= 0,106
Sulphate of lime - -	= 5 $\frac{5}{52}$ grains - -	= 0,294
Carbonate of magneſia	= 10 $\frac{5}{8}$ grains - -	= 0,577
Sulphate of magneſia -	= 363 $\frac{13}{16}$ grains -	= 20,812
Muriate of magneſia -	= 7 $\frac{6}{14}$ grains - -	= 0,512

SELTZER

SELTZER WATER.

Weight - - - - - = 17932 $\frac{17}{32}$ grains - = 1000
Specific gravity - - - - = 1,0027
Pure air - - - - - - = $\frac{43}{108}$ cubic inches = 0,011
Carbonic acid - - - = 24 cubic inches = 0,910
Carbonate of lime - - = 7 $\frac{3}{32}$ grains - = 0,396
Carbonate of magneſia = 12 $\frac{1}{2}$ grains - = 0,697
Carbonate of ſoda - - = 10 $\frac{6}{32}$ grains - = 0,566
Muriate of ſoda - - - = 46 $\frac{11}{32}$ grains - = 2,684

SPA WATER.

Weight - - - - = 17902 $\frac{1}{8}$ grains - = 1000
Specific gravity - - - = 1,0010
Carbonic acid - - - = 18 cubic inches = 0,684
Carbonate of lime - - = 3 $\frac{19}{32}$ grains - = 0,201
Carbonate of magneſia = 8 $\frac{7}{15}$ grains - - = 0,479
Carbonate of ſoda - - = 3 $\frac{19}{32}$ grains - - = 0,201
Carbonate of iron - - = 1 $\frac{3}{8}$ grains - - = 0,077
Muriate of ſoda. - - = $\frac{8}{19}$ grains - - = 0,023

PYRMONT WATER.

Weight - - - - = 17927 $\frac{2}{15}$ grains = 1000
Specific gravity - - - = 1,0024
Carbonic acid - - - = 37 $\frac{2}{3}$ cubic inch. = 1,429
Carbonate of lime - - = 8 $\frac{7}{15}$ grains - = 0,473
Carbonate of magneſia = 19 $\frac{1}{20}$ grains - = 1,063
Carbonate of iron - - = 1 $\frac{3}{}$ grains - = 0,077
Sulphate of lime - - = 16 $\frac{3}{10}$ grains - - = 0,909
Sulphate of magneſia - = 10 $\frac{3}{8}$ grains - - = 0,579
Muriate of ſoda - - - = 2 $\frac{31}{32}$ grains - = 0,165

WATER OF ST. CHARLES IN BOHEMIA.

Heat 58 $\frac{2}{5}$.
Weight - - - - - = 17900 grains - = 1000
Specific gravity - - - =

Sul-

Sulphurated hidrogen gas	=	24 cubic inches	=	0,442
Carbonate of lime - -	=	10 $\frac{5}{32}$ grains -	=	0,568
Carbonate of ſoda - -	=	28 $\frac{3}{8}$ grains -	=	1,585
Sulphur - - - - - -	=	3 $\frac{7}{19}$ grains -	=	0,188
Sulphate of ſoda - -	=	100 $\frac{1}{8}$ grains -	=	5,593

WATER OF AIX-LA-CHAPELLE.

Heat 49 $\frac{3}{5}$

Weight - - - - - -	=	17897 grains -	=	1000
Specific gravity - - -	=			
Sulphurated hidrogen gas	=	24 cubic inches	=	0,443
Carbonate of lime - -	=	11 $\frac{13}{32}$ grains -	=	0,638
Carbonate of ſoda - -	=	29 $\frac{5}{8}$ grains - -	=	1,655
Sulphur - - - - - -	=	3 $\frac{7}{19}$ grains -	=	0,188
Muriate of ſoda - - -	=	12 $\frac{9}{32}$ grains -	=	0,692

56. Lately, art has gained much in the imitation of mineral waters, particularly of thoſe which are impregnated with elaſtic fluids, and are indebted to theſe for their virtues. By the help of machines, exerting great preſſure, water is made to imbibe four, five, or even ſix times its bulk of carbonic acid, ſo that art thus impregnates it with more than nature does. The ſame is effected with ſulphurated hidrogen gas, and even with oxigen gas; and there is reaſon to preſume, that by this proceſs will be formed a new Materia Medica, derived from the properties of elaſtic fluids.

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END OF THE FOURTH VOLUME.

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